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compatible
micro

auto
service timer

TTLs

74 SERIES

7400	0.30
7401	0.30
7402	0.30
7403	0.30
7404	0.36
7405	0.30
7406	0.40
7407	0.40
7408	0.30
7409	0.30
7410	0.30
7411	0.30
7412	0.30
7413	0.50
7414	0.70
7416	0.36
7417	0.40
7420	0.30
7421	0.60
7422	0.36
7423	0.36
7425	0.40
7426	0.40
7427	0.32
7428	0.43
7430	0.30
7432	0.36
7433	0.30
7437	0.30
7438	0.40
7439	0.40
7440	0.40
7441	0.90
7442A	0.70
7443A	1.00
7444	1.10
7445	1.00
7446A	1.00
7447A	1.00
7448	1.00
7450	0.36
7451	0.35
7453	0.38
7454	0.38
7460	0.55
7470	0.50
7472	0.45
7473	0.45
7474	0.50
7475	0.60
7476	0.45
7480	0.65
7481	1.80
7483A	1.05
7484A	1.25
7485	1.10
7486	0.42
7489	2.10
7490A	0.55
7491	0.70
7492A	0.70
7493A	0.55
7494	1.10
7495A	0.60
7496	0.80
7497	2.10
74100	1.90
74107	0.50
74109	0.75
74110	0.75
74111	0.55
74116	1.70
74118	1.10
74119	1.70
74120	1.00
74121	0.55
74122	0.70
74123	0.80
74125	0.65
74126	0.55
74128	0.55
74132	0.75
74136	0.70
74141	0.90
74142	2.50
74143	2.70
74144	2.70
74145	1.10
74147	1.70
74148	1.40
74150	1.75
74151A	0.70
74153	0.80
74154	1.40
74155	0.80
74156	0.90
74157	0.80
74159	1.75
74160	1.10
74161	0.80
74162	1.10
74163	1.10
74164	1.20
74165	1.10
74166	1.40
74167	4.00
74170	2.00
74172	4.20
74173	1.40
74174	1.10
74175	1.05
74176	1.00
74178	1.50
74179	1.50
74180	1.00
74181	3.40
74182	1.40
74184	1.80
74185A	1.80
74190	1.30
74191	1.30
74192	1.10
74193	1.15
74194	1.10
74195	0.80
74196	1.30
74197	1.10
74198	2.20
74199	2.20
74221	1.10
74251	1.00
74259	1.50
74265	0.80
74273	2.00
74276	1.40
74278	1.70
74279	0.90
74283	1.05
74285	3.20
74290	0.90
74293	0.90
74298	1.80
74351	2.00
74365A	0.80
74366A	0.80
74367A	0.80
74368A	0.70
74376	1.60
74390	1.10
74393	1.20
74490	1.10
74393	1.20
74490	1.40

74LS SERIES

74LS00	0.24
74LS01	0.24
74LS02	0.24
74LS03	0.24
74LS04	0.24
74LS05	0.24
74LS08	0.24
74LS09	0.24
74LS10	0.24
74LS11	0.24
74LS12	0.24
74LS13	0.34
74LS14	0.50
74LS15	0.24
74LS20	0.24
74LS21	0.24
74LS22	0.24
74LS24	0.50
74LS26	0.24
74LS27	0.24
74LS28	0.24
74LS30	0.24
74LS32	0.24
74LS33	0.24
74LS37	0.24
74LS38	0.24
74LS40	0.24
74LS42	0.50
74LS47	0.80
74LS48	0.90
74LS51	0.24
74LS54	0.24
74LS55	0.24
74LS73A	0.30
74LS74A	0.35
74LS75	0.45
74LS76A	0.36
74LS78	0.42
74LS83A	0.70
74LS85	0.75
74LS86	0.35
74LS90	0.48
74LS91	0.90
74LS92	0.35
74LS93	0.54
74LS95B	0.75
74LS96	0.90
74LS107	0.40
74LS109	0.40
74LS112	0.45
74LS113	0.45
74LS114	0.45
74LS122	0.70
74LS123	0.80
74LS124/629	1.40
74LS125	0.50
74LS126	0.50
74LS132	0.65
74LS133	0.50
74LS136	0.45
74LS138	0.55
74LS139	0.55
74LS145	0.95
74LS147	1.75
74LS148	1.40
74LS151	0.65
74LS152	2.00
74LS153	0.65
74LS154	1.60
74LS155	0.65
74LS156	0.65
74LS157	0.50
74LS158	0.65
74LS160A	0.75
74LS161A	0.75
74LS162A	0.75
74LS163A	0.75
74LS164	0.75
74LS165A	1.30
74LS166A	1.50
74LS168	1.30
74LS169	1.00
74LS170	1.40
74LS173A	1.00
74LS174	0.75
74LS175	0.75
74LS181	2.00
74LS183	1.90
74LS190	0.75
74LS191	0.75
74LS192	0.80
74LS193	0.80
74LS194A	0.75
74LS195A	0.75
74LS196	0.80
74LS197	0.80
74LS221	1.00
74LS240	0.90
74LS241	0.90
74LS242	0.90
74LS243	0.90
74LS244	0.80
74LS245	1.00
74LS247	1.10
74LS248	1.10
74LS249	1.10
74LS251	0.75
74LS253	0.75
74LS256	0.90
74LS257A	0.70
74LS258A	0.70
74LS259	1.20
74LS260	0.75
74LS261	1.20
74LS266	0.60
74LS273	1.25
74LS279	0.70
74LS280	1.90
74LS283	0.80
74LS290	0.80
74LS292	9.00
74LS293	0.80
74LS295	1.40
74LS297	9.00
74LS298	1.00
74LS299	2.20
74LS231	3.70
74LS324/624	3.50
74LS348	2.00
74LS352	1.20
74LS353	1.20
74LS356	2.10
74LS363	1.80
74LS364	1.80
74LS365	0.50
74LS366	0.50
74LS367	0.52
74LS368	0.50
74LS373	0.90
74LS374	0.90
74LS375	0.75
74LS377	1.10
74LS378	0.95
74LS379	1.40
74LS381	4.50
74LS390	0.60
74LS393	1.10
74LS395A	1.00
74LS399	1.40
74LS445	1.80
74LS465	1.20
74LS467	1.80
74LS540	1.00
74LS541	1.00
74LS608	7.00
74LS610	19.00
74LS612	19.00
74LS624	3.50
74LS626	2.25
74LS628	2.25
74LS629	1.40
74LS640	3.00
74LS640-1	3.00
74LS641	2.00
74LS642	2.50
74LS642-1	3.00
74LS643	2.50
74LS643-1	3.00
74LS644	3.50
74LS645	2.00
74LS645-1	4.00
74LS668	0.90
74LS669	0.90
74LS670	1.80
74LS682	2.50
74LS684	3.50
74LS687	3.50
74C922	6.50
74C923	6.50
74C925	6.50
74C926	6.50
74C928	6.50

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4000	0.20
4001	0.24
4002	0.25
4006	0.70
4007	0.25
4008	0.60
4009	0.45
4010	0.60
4011	0.24
4012	0.25
4013	0.36
4014	0.60
4015	0.70
4016	0.36
4017	0.55
4018	0.60
4019	0.60
4020	0.80
4021	0.60
4022	0.70
4023	0.30
4024	0.48
4025	0.24
4026	0.90
4027	0.40
4028	0.60
4029	0.75
4030	0.35
4031	1.25
4032	1.00
4033	1.25
4034	2.50
4035	0.70
4036	2.50
4037	1.10
4038	1.00
4039	2.50
4040	0.60
4041	0.55
4042	0.50
4043	0.60
4044	0.60
4045	1.00
4046	0.60
4047	0.60
4048	0.55
4049	0.36
4050	0.35
4051	0.65
4052	0.60
4053	0.60
4054	0.80
4055	0.80
4056	0.85
4059	4.00
4060	0.70
4063	0.85
4066	0.40
4067	2.30
4068	0.25
4067	0.24
4068	0.25
4069	0.24
4070	0.24
4071	0.24
4072	0.24
4073	0.24
4075	0.24
4076	0.65
4077	0.25
4078	0.25
4081	0.24
4082	0.25
4085	0.60
4086	0.75
4089	1.20
4093	0.35
4094	0.90
4095	0.90
4096	0.90
4097	2.70
4098	0.75
4099	0.90
4501	0.36
4502	0.55
4503	0.36
4504	0.95
4505	3.60
4506	0.90
4507/4030	0.35
4508	1.20
4510	0.55
4511	0.55
4512	0.55
4513	1.50
4514	1.10
4515	1.10
4516	0.55
4517	2.20
4518	0.48
4519	0.32
4520	0.60
4521	1.15
4522	0.80
4526	0.70
4527	0.80
4528	0.65
4529	1.00
4531	0.75
4532	0.65
4534	3.80
4536	2.50
4538	0.75
4539	0.75
4541	0.90
4543	0.70
4551	1.00
4553	2.40
4555	0.36
4556	0.50
4557	2.40
4560	1.40
4566	1.40
4568	2.40
4569	1.70
4572	0.45
4583	0.90
4584	0.48
4585	0.60
4724	1.50
14411	9.00
14412	7.50
14416	3.00
14419	2.60
14490	4.20
14495	4.50
14500	6.50
14599	2.00
22100	3.50
22101	7.00
22102	7.00
40014	0.48
40085	1.20
40097	0.36
40098	0.40
40100	1.50
40101	1.25
40102	1.50
40103	2.00
40104	1.20
40105	1.50
40106	0.48
40107	0.55
40108	3.20
40109	1.20
40110	2.25
40114	2.25
40147	2.80
40163	1.00
40173	1.20
40174	1.00
40175	1.00
40192	1.00
40193	1.00
40194	1.00
40244	1.50
40245	1.50
40257	1.80
40373	1.80
40374	1.80
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CA3046	0.70
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CA3060	3.50
CA3080E	0.70
CA3086	0.60p
CA3089E	2.10
CA3090AQ	3.75
CA3130E	0.90
CA3130T	1.30
CA3140E	0.45
CA3140T	1.00
CA3146	2.25
CA3160E	0.90
CA3161E	2.00
CA3162E	6.00
CA3189E	2.70
CA3240E	1.50
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D7002	6.00
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HA1366	1.90
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ICM7555	0.90
ICM7556	1.40
LC7120	3.00
LC7130	3.00
LC7431	3.50
LC7137	3.50
LF347	1.20
LF351	0.60
LF353	0.90
LF355	0.90
LF356N	0.95
LF357	1.00
LM10CLH	4.50
LM301A	0.30
LM307	0.45
LM308CN	0.75
LM310	2.25
LM311	0.60
LM318	1.50
LM319	1.80
LM324	0.45
LM334Z	1.15
LM335Z	1.30
LM336	1.60
LM339	0.40
LM348	0.60
LM349CH	3.60
LM358P	0.50
LM377	3.00
LM380N-8	1.50
LM380N	1.50
LM381AN	1.70
LM382	2.00
LM383	3.25
LM384	2.20
LM386N-1	1.00
LM387	2.70
LM389	1.80
LM391	1.80
LM392N	1.10
LM393	0.85
LM394CH	4.00
LM709	0.35
LM710	0.48
LM711	1.00
LM723	0.60
LM725CN	3.00
LM733	0.65
LM741	0.22
LM747	0.70
LM748	0.30
LM1011	4.80
LM1014	1.50
LM1801	3.00
LM1830	2.50
LM1871	3.00
LM1872	3.00
LM1886	5.50
LM1889	3.50
LM2917	3.00
LM3302	0.90
LM3900	0.80
LM3909	1.00
LM3911	1.80
LM3914	3.50
LM3915	3.40
LM3916	3.40
LM13600	1.50
M51513L	2.30
M51516L	4.50
MB3712	2.00
MC1310	1.50
MC1413	0.75
MC1458	0.45
MC1495L	3.00
MC1496	0.70
MC3340	2.00
MC3401	0.70
MC3403	0.65
MF10CN	3.00
MK50240	9.00
MK50398	7.90
ML920	5.00
ML922	4.00
MM66221A	3.00
NE531	1.20
NE555	0.22
NE556	0.60
NE564	4.00
NE565	1.20
NE566	1.50
NE567	1.25
NE570	4.00
NE571	2.50
NE592	0.90
NE5532P	1.50
NE5533P	1.60
NE5534P	1.20
NE5534AP	1.50
OP-07EP	5.00
PLL02A	5.00
RC4136	0.55
RC4151	2.00
RC4195	1.50
RC4558	0.55
S566B	2.20
S50240	9.00
SAA1900	16.00
SFF96364	8.00
SL490	3.00
SN76033N	3.00
SN76489	4.00
SN76495	4.00
SN76660	1.20
SPO256AL2	7.00
TA7120	1.20
TA130	1.40
TA7204	1.50
TA7205	0.90
TA7222	1.50
TA7310	1.50
TBA231	1.20
TBA800	0.80
TBA810	0.90
TBA820	0.90
TBA820M	0.75
TBA920	2.00
TBA950	2.25
TC9109	5.00
TCA210	3.50
TCA220	3.50
TCA940	1.75
TDA1010	2.25
TDA1022	4.00
TDA1024	1.10
TDA1170S	3.00
TDA2002	3.25
TDA2003	1.90
TDA2004	2.40
TDA2006	3.20
TDA2020	3.20
TDA2030	2.50
TDA2591	4.00
TDA3810	7.50
TDA7000	3.50
TEA1002	7.00
TL061CP	0.40
TL062	0.60
TL064	0.90
TL071	0.40
TL072	0.70
TL074	1.10
TL081	0.35
TL082	0.55
TL083	0.75
TL084	1.00
TL094	2.00
TL170	0.50
TL430C	1.20
UAA1003-9	9.35
UA759	3.20
UA2240	1.20
UAA170	1.70
UCN4801A	5.50
ULN2003A	0.75
ULN2004A	0.75
LN2068	2.90
ULN2802	1.90
ULN2803	1.80
ULN2804	1.90
UPC575	2.75
UPC592H	2.00
UPC1156H	3.00
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XR210	4.00
XR2206	4.00
XR2207	3.75
XR2211	5.75
XR2216	6.75
XR2240	1.20
ZN404	1.20
ZN414	0.80
ZN419P	1.75
ZN423E	1.30
ZN424E	1.30
ZN425E8	3.50
ZN426E8	3.00
ZN427E8	6.00
ZN428E8	4.50
ZN429E8	2.25
ZN447E	9.50
ZN449E	3.00
ZN450E	7.50
ZN459CP	3.00
ZN1034E	2.00
ZN1040	6.60
ZNA134J	23.00
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8703CJ	12.00

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6809	6.50
6809E	12.00
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8039	4.20
8080A	4.20
8085A	3.00
8086	22.00
8088	17.50
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Z80B	7.00

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3242	8.00
3245	4.50
6520	3.00
6522	3.50
6552	2.50
6522A	5.50
6532	4.80
6551A	5.25
6821	1.50
68B21	2.20
6829	12.50
6840	3.75
68B40	6.00
6850	1.60
68B50	2.50
6852	2.50
6854	6.50
68B54	8.00
6875	5.00
8154	8.50
8155	3.80
8156	3.80
8205	2.25
8212	2.20
8216	1.60
8224	P.O.A.
8226	4.25
8228	4.50
8243	2.60
8250	9.50
8251A	3.25
8253C-5	3.50
8255AC-5	3.80
8256	18.00
8257C-5	4.00
8259C-5	4.00
8275	29.00
8279C-5	4.80
8283	4.00
8282	4.50
8284	4.60
8287	4.25
8288D	11.00
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2147	4.00
4116-15	4.50
4116-20	1.50
4118-3	5.00
41256-20	10.00
4164-15 (TI)	5.00
4164-15	3.00
4164-20	3.00
4416-15	4.00
4532-20	2.50
4816AP-3	2.00
5101/5501	3.70
5514/5114	4.50
5516	5.50
6116P-3	3.50
6116LP-3	4.00
6264-15	10.00
6810	1.60
74S189	2.25
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93415	6.00
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ROMS/PROMS

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24S10	2.50
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74S288	1.80
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EE PROM

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EPROMS

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2708	4.00
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2716-35	5.50
2732	4.50
2732A-2	7.00
2732A-30	6.00
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2764-25	4.50
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27128-30	9.50
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EF9365	25.00
EF9366	25.00
EF9367	36.00
MC6845	6.50
MC6845SP	6.50
MC6847	6.50
SFF96364	8.00
TMS9918	15.00
TMS9928	10.00
TMS9929	10.00

CRYSTALS

32.768 kHz	1.00
1.00 MHz	2.70
1.8432 MHz	2.25
2.00 MHz	2.25
2.45760 MHz (S)	2.00
2.5 MHz	2.50
2.662 MHz	2.50
3.12 MHz	1.75
3.276 MHz	1.50
3.5795 MHz	1.00
4.00 MHz	1.40
4.194 MHz	1.50
4.43 MHz	1.00
4.608 MHz	2.50
4.9152 MHz	2.00
5.000 MHz	1.50
5.068	1.75
6.00 MHz	1.40
6.144 MHz	1.40
7.00 MHz	1.50
7.168 MHz	1.75
8.00 MHz	1.50
8.867 MHz	1.75
10.00 MHz	1.75
10.50 MHz	2.50
10.70 MHz	1.50
11.00 MHz	3.00
12.00 MHz	1.50
14.00 MHz	1.75
14.318 MHz	1.60
14.756MHz	2.50
15.00 MHz	2.00
16.00 MHz	2.00
17.734 MHz	1.50
18.00 MHz	1.50
18.432 MHz	1.50
19.969 MHz	1.50
20.000 MHz	1.75
24.000 MHz	1.50
48.00 MHz	1.75
116 MHz	2.50
PXO1000	12.00

DISC CONTROLLERS

6843	8.00
8272	13.00
D765A	13.00
FD1771	20.00
FD1791	20.00
FD1793	20.00
FD1797	22.00
WD2793	27.00
WD2797	27.00
WD1691	15.00
WD2143	8.00

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RO-3-2513	UC7.50
RO-3-2513	LC7.00

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MC6818P	4.00
MM58174AN	9.00
MSM5832RS	3.50

BAUDRATE GENERATOR

MC14411	7.50
COM8116	6.50
4702B	7.50

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AY-5-2376	11.50
AY5-3600	7.50
74C922	6.50
74C923	6.50

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8 MHz	4.50
SOUND & VISION 12 MHz	12.00

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AD7581	15.00
ADC0808	12.00
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AM25LS2521	3.50
AM25LS2538	3.50
AM26LS31	1.20
AM26LS32	1.20
AM7910DC	25.00
D7002	6.00
DAC80-CB1-V	28.00
DM8131	6.00
DP8304	3.50
DS3691	3.50
DS8830	1.40
DS8831	1.50
DS8832	1.50
DS8833	2.25
DS8836	1.50
DS8838	2.25
MC1488	0.60
MC1489	0.60
MC3446	2.50
MC3459	4.50
MC3470	4.75
MC3480	8.50
MC3486	2.25
MC3487	2.25
MC4024	5.50
MC4044	5.50
MC14411	9.00
MC14412	7.50
ULN2003	0.75
75107	0.90
75108	0.90
75109	1.20
75110	0.90
75112	1.60
75113	1.20
75114	1.40
75115	1.40
75121	1.40
75122	1.40
75150P	1.20
75154	1.20
75159	2.20
75160	5.00
75161	3.50
75162	4.00
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75182	0.90
75188	0.60
75189	0.60
75365	1.50
75451	0.50
75452	0.50
75453	0.70
75454	0.70
75480	1.50
75491	0.65
75492	0.65
8T26	1.20
8T28	1.20
8T95	1.20
8T96	1.20
8T97	1.20
8T98	1.20
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81LS96	2.20
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9602	3.00
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TELETEXT DECODER

SAA5020	6.00
SAA5030	7.00
SAA5041	16.00
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AY-3-1015P	3.00
AY-5-1013P	3.00
COM8017	3.00
IM6402	4.50

VOLTAGE REGULATORS

1A FIXED VOLTAGE PLASTIC TO220

+VE			−VE	
5 V	7805	0.45	7905	0.50
6 V	7806	0.50	7906	0.50
8 V	7808	0.50	7908	0.50
12 V	7812	0.45	7912	0.50
15 V	7815	0.50	7915	0.50
18 V	7818	0.50	7918	0.50
24 V	7824	0.50	7924	0.50

1A FIXED VOLTAGE PLASTIC TO92

5 V	78L05	0.30	15 V	78L15	0.30
6 V	78L06	0.30	5 V	79L05	0.45
8 V	78L08	0.30	12 V	79L12	0.50
12 V	78L12	0.30	15 V	17L15	0.50

OTHER REGULATORS

LM309K	1.40
LM323K	3.50
78HO5KC 5 A 5 V	5.75
78H12	6.40
78PO5	9.00

SWITCHING REGULATORS

ICL7660	2.50
SG3524	3.00
TL494	3.00
TL497	3.00
78S40	2.50
RC4195	1.50

VARIABLE REGULATORS

LM305AH	2.50	LM723N	0.50
LM317T	1.50	78HGKC	7.00
LM317K	2.40	78GUIC	2.25
LM337T	2.25	79HGKC	6.75
LM350T	4.00	79GUIC	2.50
LM396K	15.00	79MGT2C	1.40

OPTO-ISOLATORS

ILD74	1.30	TIL112	0.70
ILQ74	2.20	TIL113	0.70
MCT26	1.00	TIL116	0.70
MCS2400	1.90	6N137	3.60
MOC3020	1.50	6N139	1.75
TIL111	0.70		

DISPLAYS

FND357	1.00	MAN6610	2.00
FND500/TIL730	1.00	NSB5881	5.70
FND507/TIL729	1.00	TIL311	6.50
MAN74/DL704	1.00	TIL729	1.00
MAN71/DL707	1.00	TIL730	1.00
MAN3640	1.75	MAN8910	1.50
MAN4640	2.00		

DISPLAY DRIVERS

9368	4.50	ULN2004	0.90
9370	4.50	ULN2068	2.90
LM3914	3.50	ULN2802	1.90
LM3915	3.50	ULN2803	1.80
LM3916	3.50	ULN2804	1.90
UDN6118	3.20	75491	0.70
UDN6184	3.20	75492	0.70
ULN2003	0.90		

OTHERS

2N5777	0.50	ORP12	1.20
BPX25	1.80	ORP60	1.20
BPW21	2.80	ORP61	1.20
OCP71	1.80	SFH205	1.00

***ATTENTION* ALL PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE**

SCRS

1A 50V	70p
5A 400V	50p
8A 600V	140p
16A100V	200p
C106D	45p
MCR101	36p
T1C44	36p
2N3525	130p
2N4444	140p
2N5060/4	40p

ZENERS

2.7V-33V	
400MW	9p
1W	15p

TRIACS

Plastic	
3A 400V	60p
6A 400V	70p
6A 500V	90p
8A 400V	75p
8A 500V	95p
12A500V	105p
16A500V	130p
T 2800D	130p
T1206D	50p
T1226D	70p

DISCRETE DISPLAYS LEDS

125″ RED TIL209	0.12
GREEN TIL211	0.16
YELLOW TIL212	0.20
Rect LEDs (R/G/Y)	0.30
CXQ (Bi Colour	1.00
10 LED Bargraph: Red	2.25
Green	2.25
0.2″ TIL220	0.15
TIL222	0.18
TIL226	0.22
TIL32	0.55
TIL78	0.55
TIL31B	1.20
TIL81	1.20
TIL100	0.75

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	50p	24 pin	75p
14 pin	42p	20 pin	60p	28 pin	100p
16 pin	45p	22 pin	65p	40 pin	130p

Turned Pin Low Profile Sockets

8 pin	20p	16 pin	30p	20 pin	40p	28 pin	65p
14 pin	25p	18 pin	35p	24 pin	55p	40 pin	90p

TRANSISTORS

BC107/8	18p	BC557B	18p	BFY50/51	30p	TIP36C	150p	2N3055	55p
BC109B	18p	BC558B	18p	BFY52	30p	TIP41C	50p	2N3442	140p
BC109/C	20p	BC559C	24p	BFY90	90p	TIP42A	60p	2N3702 3	25p
BC141	40p	BCY71	36p	MJ2501	225p	TIP42C	65p	2N3704 5	25p
BC161	40p	BCY72	30p	MJ2955	90p	TIP47	90p	2N3706 7 8	25p
BC177	30p	BD131	75p	MJ3001	225p	TIP54	160p	2N3773	200p
BBC179	30p	BD132	80p	MJE2955	150p	TIP55	180p	2N3819	40p
BC182/L	15p	BD135	40p	MJE3055	125p	TIP125	70p	2N3866	90p
BC184/L	20p	BD136	40p	MPF102	40p	TIP2955	90p	2N3904 6	22p
BC212/L	16p	BD139	40p	MPF103/4	40p	TIP3055	70p	2N4871	50p
BC213/L	16p	BD241B	75p	MPF105	40p	2N2160	350p	2N5245	40p
BC214/L	18p	BD242B	75p	MPSA12	50p	2N2219A	30p	2N5457 8	30p
BC327	16p	BD244B	40p	TIP29C	40p	2N2222A	30p	2N5459	30p
BC338	16p	BF256B	50p	TIP31B	40p	2N2484	30p	2N5485	45p
BC477	36p	BF257/8	40p	TIP31C	45p	2N2646	50p	2N5883	375p
BBC516/7	50p	BF259	40p	TIP32C	45p	2N2905A	30p	2N6027	30p
BBC547/B	20p	BF337	36p	TIP33C	80p	2N3053	36p	3N128	200p
BBC548C	16p	BFR80/81	32p	TIP35C	140p	2N3054	60p	3N140 1	200p
								40673	90p

IDC CONNECTORS

	10 way	20 way	26 way	34 way	40 way	50 way
Header Plug	90p	145p	175p	200p	220p	235p
Receptacle	85p	125p	150p	160p	190p	200p
Edge Conn.	120p	195p	240p	320p	340p	390p

EURO CONNECTORS

	Plug	Socket
DIN 41612 2 - 32-way	300p	350p
angled 2 - 32-way	350p	400p
angled 3 - 32-way	400p	—
(for 2 - 32 way specify a - b or a - c)		
DIN 41617 21-way	160p	165p
DIN 41617 31-way	170p	170p
DIN 41612		
2 × 32 way St Pin	230p	275p
2 × 32 way Ang Pin	275p	320p
3 × 32 way St Pin	260p	300p
3 × 32 way Ang Pin	375p	400p
1 DC Skt A + B	425p	
A + C	425p	

For 2 × 32 way please specify spacing (A + B, A + C)

DIODES

BY127	12p	OA200	9p	IN4003/4	5p
OA47	10p	OA202	10p	IN4006/7	7p
OA90	9p	IN914	4p	IN5401/2	12p
OA91	9p	IN4148	4p	IN5403/4	14p
OA95	9p	IN4001/2	5p	IS920	9p

BRIDGES

1A50V	19p	2A400V	45p	6A100V	100p
1A100V	20p	3A200V	60p	6A400V	120p
1A600V	30p	4A100V	95p	8A100V	150p
2A50V	30p	4A400V	100p	10A100V	180p
2A100V	35p	6A50V	80p	10A400V	200p

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way	50 way
		MALE			
solder	60p	85p	1.25p	2.40p	4.00p
angled	1.20p	1.80p	2.40p	3.50p	—
		FEMALE			
solder	90p	1.30p	1.95	2.90p	5.00p
angled	1.60p	2.10p	2.90p	4.40p	—
hood (top/side entry)	90p	85p	90p	1.00p	—

25 way Centronix Type Conn. .... 5.50 pound

37 way Centronix Type Conn. .... 5.50 pound

IDC 25 way plug 3.85p Socket 4.50p.

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Access

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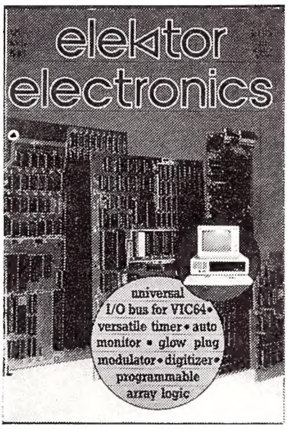

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Shining a light on new technology

A/D and D/A conversion 5-22
A fresh look at the state of the art.

programmable timer 5-26
A truly versatile timer/calendar with a host of facilities.

universal I/O bus 5-35
Primarily intended for the Commodore 64, this bus can also be used with many other computers.

an IBM compatible micro 5-40
In this short introduction, we explain the intent of the project which will be published next month.

glow plug modulator 5-45
A means of making your model (diesel) engine start first time — every time!

digitizer 5-48
This unit provides the staple diet for your computer from all sorts of (analogue) inputs.

programmable array logic 5-52
This modern technology deserves to be better known to all electronics designers.

automonitor 5-60
With petrol now past the £2 per gallon barrier, this unit may help you keep your running costs down.

panorama mixer 5-67
A four-channel mixer that enables you to position a sound anywhere in the audio spectrum.

---

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Sound intensity is usually measured in decibels, in which case it is known as the intensity level, n, and is equal to 10 times the logarithm to the base 10 of the ratio of the sound intensity, p, in watts per square centimetre to the reference level, p_r, in watts per square centimetre. In formula form,

$n = [10\log_{10}(p/p_r)]$ dB.

One decibel represents an increase in intensity of 26 per cent, which is about the smallest change the human ear can detect.

The decibel is not a measure of loudness since the sensitivity of the human ear to changes in intensity varies with frequency. The unit of equivalent loudness of a sound is the phon; this is a measure of the intensity level relative to a reference tone of defined intensity and frequency. The internationally accepted standard reference tone has a root-mean-square sound pressure of 2.04×10^{-5} N/m² (pascal) and a frequency of 1000 Hz, when it is equivalent to a sound intensity of 10^{-16} W/cm².

The decibel and phon scales are not identical, because the phon is measured subjectively, although between 500 Hz and 10 000 Hz they are almost the same.

---

lektor datacard	junction field-effect transistors BF246A...C

type	characteristics	limits
on n-channel T designed VHF and F applications	zero-gate voltage drain current, I_{DSS} ($U_{DS}=15$ V; $U_{GS}=0$ V) BF245A 30...180 mA BF 246B 60...140 mA BF246C 110...250 mA gate-souce voltage, $-U_{GS}$ BF246A 1.5...4 V ($U_{DS}=15$ V; $I_D=200$ μA) BF246B 3...7 V BF246C 5.5...12 V gate reverse current, $-I_{GSS}$ max 5 nA ($-U_{GS}=15$ V; $U_{DS}=0$ V forward transfer admittance, Y_{fs} min 4.5 mS ($U_{DS}=15$ V; $I_D=10$ mA; $f=1$ kHz) typ. 17 mS	U_{DS} 25 V U_{DG} 25 V U_{GS} −25 V I_G 10 mA P_D 300 mW (up to T_a = 25°C); derate above 25°C by 2.95 mW/°C T_j 150°C

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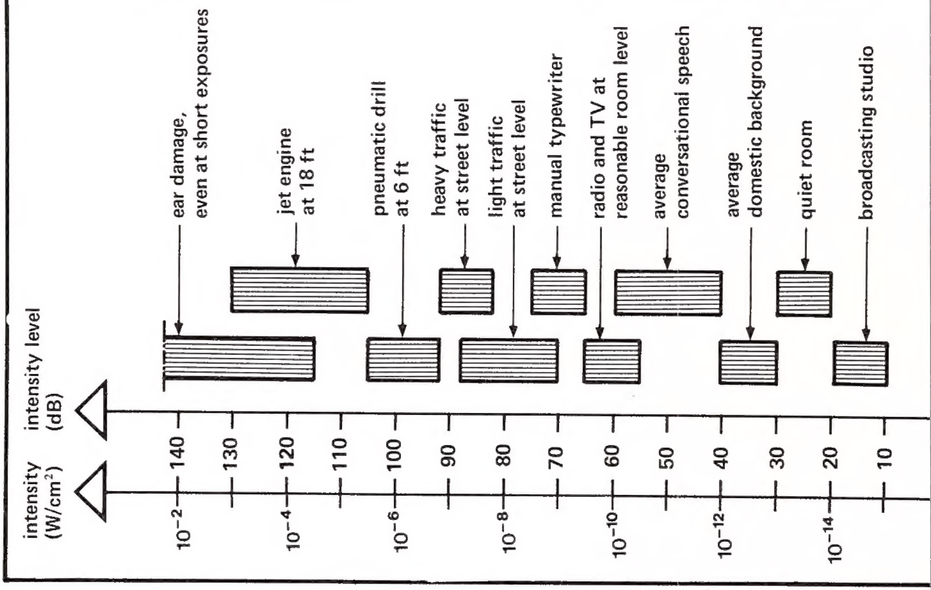

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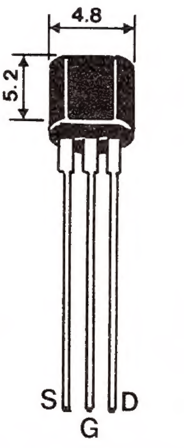
elektor datacard | junction field-effect transistors BF246A...C

TO 92 – var



dimensions in mm

output capacitance, C_{oss} ($U_{DS} = 15$ V; $I_D = 10$ mA, $f = 1$ MHz)	typ. 5.0 pF
reverse transfer capacitance, C_{rss} ($U_{DS} = 15$ V; $I_D = 10$ mA; $f = 1$ mHz)	typ. 3.5 pF
cut-off frequency, f_{gfs} ($U_{DS} = 15$ V; $U_{GS} = 0$ V) (this is the frequency at which Y_{fs} is 0.7 of its value at 1 kHz)	typ. 450 MHz
thermal resistance, R_{th}	
junction-ambient, in free air	0.25 K/mW
junction-ambient with device mounted on pcb with spot for drain of not less than 10 × 10 mm and connecting wires not longer than 3 mm	0.20 K/mW

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elektor contents

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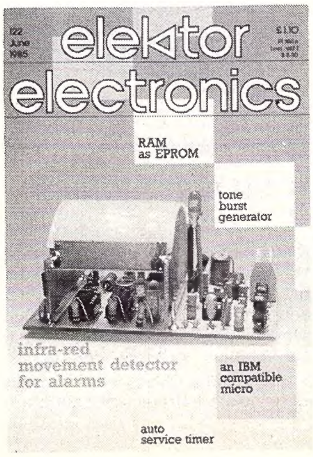

Next month we publish our double issue *Summer Circuits 1985*. As in previous years, this will contain well over 100 practical circuits for use over the whole spectrum of electronics. Don't miss it!

This month's cover shows the *infra-red movement detector* which is intended for use in burglar alarm installations. In these days of ever-growing numbers of break-ins and burglaries, this project should appeal to many worried householders.

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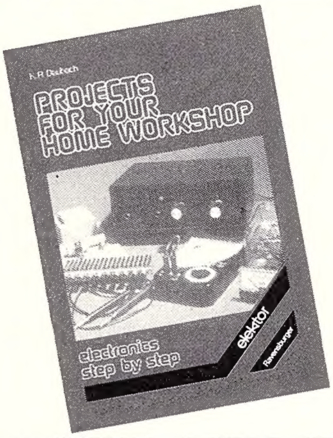

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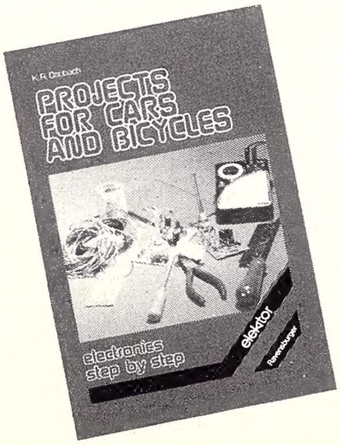

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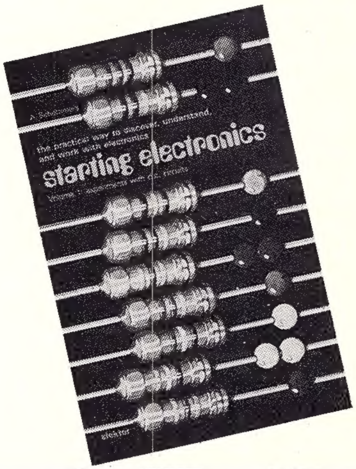
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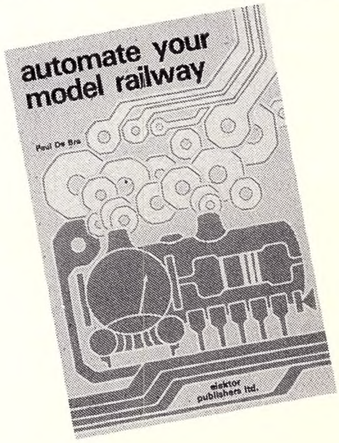

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CA3014	275
CA3018	86
CA3019	80
CA3020	210
CA3023	210
CA3028A	110
CA3035	255
CA3036	270
CA3043	275
CA3045	385
CA3046	70
CA3059	325
CA3075	213
CA3080E	70
CA3081	190
CA3085	160
CA3086	60
CA3089E	215
CA3090AQ	375
CA3123E	165
CA3130	90
CA3140	45
CA3160	90
CA3161	180
CA3162	450
CA3189	275
FC347	175
FC353	175
FC525	525
HA 1336W	240
HA1388	235
ICL7106	675
ICL7107	975
ICL7611	99
ICL7660	248
ICL8038C	345
ICL8211A	225
ICM7205A	1150
ICM7207	475
ICM7215	1050
ICM7216AJ	£22
ICM7216B	£22
ICM7216C	£22
ICM7217A	750
ICM7224	£11
ICM7240	300
ICM7555	105
ICM7556	150
LA3350	250
LA4031P	340
LA4032	295
LA4400	350
LA4422	320
LC7120	300
LC7130	320
LC7137	350
LF347	150
LF351	60
LF353	90
LF355	90
LF356	90
LF357	100
LF398	495
LM10	325
LM301A	30
LM307	45
LM308T	75
LM311	60
LM318N	175
LM319	180
LM324A	45
LM334Z	150
LM335Z	135
LM337	275
LM339	40
LM348	60
LM349	125
LM358	50
LM377	210
LM379	495
LM380	115
LM381N	175
LM382	200
LM384	225
LM386	110
LM387	200
LM389	160
LM393	85
LM394CH	380
LM558	170
LM725CN	300
LM733	65
LM1458	45
LM1871	300
LM1875	475
LM1889	400
LM2907	395
LM2917	325
LM3900	70
LM3909N	100
LM3911	185
LM3914	300
LM3915	345
LM3916	300
LM13600	150
LS7220	280
M51513L	230
M51515L	320
M51516L	475
MB3712	200
MB3756	440
MC1204	250
MC1301	90
MC1303	98
MC1304P	260
MC1310P	150
MC1445	250
MC145106	695
MC1455	50
MC1458	35
MC1469	300
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	75
MC3401	50
MC3403	95
MC3404	85
MC3405	150
MC3422	00
MC3423	80
MC3442	00
MC3487	00
MC4016	00
MF10	300
MFC6040	75
ML924	275
NE515	275
NE529	225
NE531	160
NE543K	225
NE544	200
NE555	25
NE556	65
NE560	350
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567V	140
NE570	410
NE571	400
NE5532	150
NE5534A	160
OM335	650
RC4136D	60
RC4558	55
S566B	225
SAB3209	425
SAB3210	325
SAB3271	485
SAB4209	595
SG3402	295
SL490	350
SL6270CD	150
SL6370	170
SN76013	350
SN76023ND	240
SN76033	350
SN76227N	95
SN76477	470
SN76488	525
SP8629	350
SPO256AL	495
TA7120	140
TA7130	150
TA7204	150
TA7205	90
TA7222	150
TAA661A	190
TAA700	275
TAA900	395
TAD100	159
TBA120S	70
TBA540Q	275
TBA550Q	330
TBA641BX or BX11	290
TBA651	190
TBA800	80
TBA810	95
TBA820	80
TBA920Q	200
TBA950	300
TBA990Q	350
TBA540	275
TCA220	350
TCA270Q	350
TCA280A	220
TCA965	180
TDA1008	310
TDA1010	235
TDA1022	499
TDA1024	115
TDA1034	350
TDA1490	350
TDA2002	325
TDA2003	198
TDA2004	270
TDA2006	320
TDA2020	320
TDA2030	190
TDB0701	420
TL170	50
TL430	90
TL497A	500
TL507	110
TL509	110
TLO61CP	40
TLO62CP	65
TLO64CN	95
TLO71CP	40
TLO72CP	75
TLO74CN	130
TLO81CP	35
TLO82CP	55
TLO83CP	75
TLO84CN	110
TLO91CP	60
UA2240	120
UA78540	230
UAA170	170
UAA180	180
ULN2003	90
ULN2004	90
ULN2283	150
ULN2803	190
UPC575	275
UPC1025H	375
UPC1156H	295
UPC1181	425
UPC1182	425
UPC1366	195
XR2206	375
XR2207	400
XR2211	575
XR2216	675
XR2266	360
ZN414	80
ZN423E	130
ZN424E	130
ZN425E	595
ZN426E	300
ZN427E	600
ZN428E	450
ZN429E	240
ZN459	245
ZN1034E	200
ZN1040E	665
ZNA234E	925

DIODES

AA119	8
AA129	10
AAY30	8
BA100	10
BY100	15
BY126	12
BY127	10
CRO33	198
OA9	10
OA47	10
OA70	9
OA79	10
OA81	10
OA85	10
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	12
1N5404	14
1N5406	15
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

VARI-CAPS

BA102	50
BB105B	40
BB106	40
BB109B	45

BRIDGE rectifiers

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	30
2A/50V	26
2A/200V	40
2A/400V	42
2A/600V	50
6A/100V	83
6A/400V	95
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56

ZENERS

Range: 2V7 to 39V 400mW **8p each**
Range: 3V3 to 33V. 1.3W **15p each**

TRIACS

3A 200V	54
3A 400V	56
8A 100V	60
8A 400V	69
8A 800V	115
12A 100V	78
12A 400V	82
12A 800V	135
16A 100V	103
16A 400V	106
16A 800V	220
25V 500V	220
25A 800V	295
T2800D	125

DIAC

ST2	25

75 SERIES

75107/8	95
75110	90
75114/5	150
75121/2	130
75150	125
75154	125
75158	150
75195	195
75182/3	99
75188/9	100
75322	140
75324	360
75325	00
75365	00
75450	86
75451/2	52
75454	70
75491/2	65

SCR THYRISTORS

5A/40V	32
5A 400V	40
5A 600V	48
8A 300V	60
8A 600V	90
12A 100V	78
12A 400V	96
12A 800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

TRANSISTORS

AD142	120
AD149	79
AD161	42
AD162	42
AF118	80
AF139	40
AF239	55
BC107	12
BC107B	14
BC108	12
BC108B	14
BC108C	14
BC109	12
BC109B	14
BC109C	14
BC114/5	30
BC117/8	25
BC137/9	40
BC140	38
BC142/3	38
BC147	12
BC147B	15
BC148	12
BC148B	15
BC149	12
BC149C	15
BC153/4	30
BC157/8	14
BC159	11
BC160	46
BC167A	14
BC168C	12
BC169C	12
BC170	20
BC171/2	12
BC173	15
BC177/8	16
BC179	20
BC181	30
BC182/3	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC186/7	28
BC212	10
BC212L	12
BC213	10
BC213L	12
BC214	10
BC214L	12
BC237/8	15
BC256B	35
BC307B	15
BC308	16
BC318	30
BC327/8	15
BC337/8	15
BC441/61	34
BC477	40
BC516/7	40
BC547/8	12
BC549C	15
BC556/7	15
BC558/9	15
BCY41/42	30
BCY58/59	36
BCY70/71	18
BCY72	25
BCY78	30
BD121	96
BD124	115
BD131/32	65
BD133	70
BD135	46
BD136/37	40
BD138/39	40
BD140	40
BD144	190
BD158	68
BD205/6	110
BD245	65
BD378	70
BD434	70
BD517	75
BD645	80
BD695A	150
BD696A	150
BF115	45
BF154/8	30
BF167	35
BF173	35
BF177	35
BF178	35
BF179	40
BF184/5	38
BF194/5	12
BF198/9	18
BF200	80
BF224A	40
BF224B	40
BF245	50
BF256A	45
BF256B	50
BF257/8	32
BF259	40
BF275	55
BF336/7	35
BF494/5	40
BFR39/40	25
BFR41/79	25
BFR80/81	25
BFR98	106
BFX29	35
BFX81	45
BFX84	35
BFX85/6	35
BFY50/51	30
BFY52	30
BFY53	35
BFY55/6	35
BFY64	40
BFY81	120
BFY90	80
BFY39	50
BSX20	30
BSX26/29	45
BSY26	35
BSY95	35
BU105	180
BU205	190
BU206	200
BU208	200
BUY69C	225
MJ2955	90
MJE170	150
MJE180	150
MJE340	54
MJE370	100
MJE371	100
MJE520	96
MJE521	96
MJE2955	99
MJE3055	70
MPF102	40
MPF103	30
MPF104	30
MPF105	30
MPF106	40
MPSA05	30
MPSA08	30
MPSA12	32
MPSA55	30
MPSA56	30
MPSA70	40
MPSU02	58
MPSU05	60
MPSU06	60
MPSU52	65
MPSU55	60
MPSU56	60
TIP29A	32
TIP29C	38
TIP30A	35
TIP30C	37
TIP31A	38
TIP31B	39
TIP31C	45
TIP32A	43
TIP32C	45
TIP33A	70
TIP33C	75
TIP34A	85
TIP34C	105
TIP35A	120
TIP35C	130
TIP36A	130
TIP36C	140
TIP41A	50
TIP41B	52
TIP42A	55
TIP42B	58
TIP120	70
TIP121/2	73
TIP141/2	120
TIP147	120
TIP2955	70
TIP3055	70
TIS44/5	45
TIS /74	50
TIS88A	50
TIS90/91	30
UC734	65
VK1010	99
VN10KM	70
VN46AF	95
VN66AF	110
VN88AF	120
VN89AF	120
ZTX300	13
ZTX301	16
ZTX302	16
ZTX303	25
ZTX304	17
ZTX314	25
ZTX326	30
ZTX341	30
ZTX451	23
ZTX500	14
ZTX501/2	15
ZTX503	18
ZTX504	25
ZTX531	25
ZTX550	25
2N697	23
2N698	40
2N699	48
2N707a	25
2N708	25
2N918	40
2N1131/2	40
2N1671b	160
2N2160	325
2N2219a	28
2N2220a	26
2N2221a	26
2N2222	25
2N2368	25
2N2369A	18
2N2483/A	27
2N2646	46
2N2904/5	28
2N2907	28
2N2926	10
2N3053	25

2N3055
2N3614
2N3702/3
2N3819
2N3820
2N3822
2N3904
2N3906
40673

RF CHOK ES Mi- niatur PCB type

1uH,
4u7, 10u,
33u,
100u,
330u,

1mH,
2m2,
10mH,
22m,
43m,
100m

TTL74

7400	25
7401	25
7402	25
7403	25
7404	30
7405	30
7406	40
7407	40
7408	25
7409	25
7410	25
7411	25
7412	25
7413	50
7414	60
7416	35
7417	35
7420	25
7421	50
7422	40
7423	35
7425	35
7426	40
7427	35
7428	35
7430	25
7432	30
7433	30
7437	30
7438	40
7440	30
7441	90
7442	65
7443	100
7444	100
7445	110
7446	110
7447	95
7448	110
7450	30
7451	30
7453	30
7454	30
7460	30
7470	50
7472	50
7473	50
7474	45
7475	55
7476	45
7480	60
7481	175
7482	100
7483	100
7484	105
7485	100
7486	40
7489	200
7490	55
7491	70
7492	110
7493	50
7494	100
7495	60
7496	75
7497	200
74100	175
74104	70
74105	70
74107	45
74109	70
74110	55
74111	55
74116	160
74118	100
74119	160
74120	90
74121	45
74122	65
74123	75
74125	60
74126	60
74128	55
74132	70
74136	50
74141	85
74142	235
74143	250
74144	250
74145	100
74147	160
74148	130
74150	170
74151	60
74153	70
74154	130
74155	75
74156	90
74157	75
74159	170
74160	100
74161	100
74162	100
74163	100
74164	110
74165	100
74166	130
74167	250
74170	190
74172	400
74173	130
74174	100
74175	100
74176	100
74177	110
74178	130
74179	130
74180	100
74181	300
74182	120
74184	170
74185	170
74190	120
74191	120
74192	120
74193	120
74194	100
74195	75
74196	120
74197	100
74198	200
74199	200
74221	200
74246	130
74247	120
74248	145
74249	175
74251	90
74259	150
74265	260
74273	180
74276	130
74278	160
74279	80
74283	100
74284	440
74285	300
74286	90
74290	80
74293	80
74297	175
74298	160
74351	180
74365	70
74366	70
74367	70
74368	70
74376	120
74390	100
74393	100
74425	60
74426	60
74490	100

74C

74C244	150
74C245	150
74C373	180
64C374	425
74C922	625
74C923	645
74C925	650

74S

74S00	40
74S02	40
74S03	40
74S04	40
74S05	40
74S08	40
74S09	40
74S10	40
74S11	40
74S15	60
74S20	40
74S22	40
74S30	60
74S32	50
74S37	50
74S38	70
74S40	40
74S51	40
74S64	40
74S65	40
74S74	70
74S85	295
74S86	100
74S112	100
74S113	100
74S114	100
74S124	300
74S132	90
74S133	50
74S134	60
74S135	110
74S138	170
74S139	170
74S140	60
74S151	140
74S153	140
74S153	140
74S157	200
74S158	190
74S162	300
74S163	300
74S168	300
74S169	300
74S174	250
74S175	300
74S181	£11
74S182	250
74S188	200
74S189	225
74S194	280
74S195	320
74S196	395
74S197	300
74S201	250
74S225	500
74S226	350
74S240	375
74S241	375
74S244	474
74S251	200
74S257	225
74S258	225
74S260	70
74S262	£10
74S274	£10
74S275	£10
74S280	425
74S281	885
74S283	295
74S287	200
74S288	180
74S289	200
74S299	595
74S301	350
74S365	250
74S373	375
74S374	375
74S381	550
74S412	380
74S470	325
74S471	600
74S472	400
74S474	400
74S475	425
74S571	300
74S573	450

74LS

74LS00	25
74LS01	25
74LS02	25
74LS03	25
74LS04	25
74LS05	25
74LS08	25
74LS09	25
74LS10	25
74LS11	25
74LS12	25
74LS13	35
74LS14	50
74LS15	25
74LS20	25
74LS21	25
74LS22	25
74LS24	50
74LS26	25
74LS27	25
74LS28	25
74LS30	25
74LS32	50
74LS33	25
74LS37	25
74LS38	25
74LS40	25
74LS42	50
74LS47	80
74LS48	90
74LS49	100
74LS51	25
74LS54	25
74LS55	25
74LS63	55
74LS73	30
74LS74	35
74LS75	45
74LS76	40
74LS78	40
74LS83	70
74LS85	70
74LS86	35
74LS90	50
74LS91	90
74LS92	55
74LS93	55
74LS95	70
74LS96	90
74LS107	40
74LS109	45
74LS112	45
74LS113	40
74LS114	40
74LS122	70
74LS123	100
74LS124	125
74LS125	100
74LS126	50
74LS132	60
74LS133	50
74LS136	45
74LS138	60
74LS139	60
74LS145	95
74LS147	165
74LS148	130
74LS151	70
74LS153	70
74LS154	155

74LS155
74LS156
74LS157
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74LS161
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74LS386
74LS390
74LS393
74LS395
74LS398
74LS399
74LS447
74LS465
74LS490
74LS540
74LS541
74LS624
74LS629
74LS640
74LS641
74LS645
74LS668
74LS669
74LS670
74LS673
74LS674
74LS682
74LS684
74LS687

ITCHES

e: 2 A, 250 V

	35p
	48p

3-MIN-
GGLE

on/off	58p
c/over	64p
centre off	85p
biased both	105p
6 tags	80p
centre off	88p
biased both	145p
3 positions' n/on	185p
e 2 way	220p

E 250 V:

1 A	14p
1 A c/off	15p
½ A	13p

HBUTTON

10 mm Button	
latching	150p
latching	200p
moment	150p
moment	200p
Non Locking	
to Make	**15p**
to Break	**25p**

**GITAST
VITCHES**
Assorted
colours
5p each

DIL SWITCHES

(SPST) 4 way **65p** 6 way **80p**
8 way **85p** 10 way **100p**
(SPDT) 4 way **190p**

ROTARY SWITCHES

(Adjustable Stop type)
1 pole/2 to 12 way; 2p/2 to 6 way:
3 pole/2 to 4 way; 4p/2 to 3 way **48p**

ROTARY: Mains: DP 250 V
4 Amp on/off **68p**

ROTARY: (Mak-a-Switch)
Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max. 6 pole/12 way + DP switch).
Mechanism only **90p**

WAFERS: (make before break)
to fit the above switch mechanism.
1 pole/12 way; 2 pole/6 way;
3 pole/4 way; 4 pole/3 way;
6-/2 way **65p**
Mains DP 4A Switch to fit **45p**
Spacers **4p**. Screen **8p**

ROCKER SWITCHES

ROCKER: 5A/250V SPST	28p
ROCKER: 10A/250V SPDT	38p
ROCKER: 10A/250V DPDT c/off	95p
ROCKER: 10A/250V DPST with neon	85p

THUMBWHEEL SWITCH
Mini front mounting

Decade Switch Module	275p
B.C.D. Switch Module	298p
Mounting Cheeks (per pair)	75p

VEROBOARD 0.1 in

	clad	plain
2½ × 3¼	95p	—
2½ × 5"	110p	—
3¾ × 3¾	110p	—
3¾ × 5"	125p	—
3¾ × 17"	420p	198p
4¾ × 17"	590p	275p
Pkt. of 100 pins	55p	
Spot face cutter	150p	
Pin insertion tool	185p	

VQ Board	195p
DIP Board	395p
Vero Strip	95p
PROTO DECs	
Veroblock	**480p**
S-Dec	**360p**
Eurobreadboard	**590p**
Bimboard 1	**575p**
Superstrip SS2	**1360p**

VERO WIRING

PEN + spool	**380p**
Spare spool	**75p**
Combs	**6p**

**DALO ETCH
RESIST PEN**
Plus spare tip **100p**

FERRIC CHLORIDE
1 lb bag Anhydrous
195p + **50p** P&P

**ULTRASONIC
TRANSDUCER**
40 kHz **395p**

COPPER CLAD BOARDS

Fibre glass	Single-sided	Double-sided
6" × 6"	100p	125p
6" × 12"	175p	225p

DIL SOCKETS

	Low Prof	Wire Wrap
8 pin	8p	25p
14 pin	10p	35p
16 pin	10p	42p
18 pin	16p	52p
20 pin	20p	60p
22 pin	22p	65p
24 pin	25p	70p
28 pin	28p	80p
40 pin	30p	99p

EDGE CONNECTORS

2 × 18 way	210p
2 × 22 way	215p
2 × 23 way	175p
2 × 25 way	285p
2 × 28 way	190p
2 × 30 way	310p
2 × 36 way	360p
2 × 40 way	380p
2 × 43 way	450p
2 × 75 way	650p

ANTEX SOLDERING IRON

C-15W	560p	CS17W	580p
G-18W	575p	XS25W	585p

Spare tips, assorted size	100p
Spare Elements	245p
Iron stand with sponge	195p

SIL SOCKET
0.1" pitch
20 way
65p

IDC CONNECTORS

PCB Plugs with latch	Pins Strt	Pins Angle	Female Header Plug	Female Card Edge Connect
10 way	90p	99p	85p	120p
16 way	130p	150p	110p	—
20 way	145p	166p	125p	195p
26 way	175p	200p	150p	240p
34 way	206p	236p	169p	320p
40 way	220p	250p	190p	340p
50 way	236p	270p	200p	395p
60 way	—	—	230p	495p

EURO CONNECTORS

	Female Strt. Pins	Socket Angle Pins	Male Strt Pins	Plug Angle Pins
DIN41617 31 way	170p	—	—	175p
DIN41612 2×32 A+B	275p	320p	220p	285p
DIN41612 2×32 A+C	295p	340p	240p	300p
DIN41612 3×32 A+B +C	360p	360p	260p	395p

DIL PLUG
(Header)

	Solder	IDC
14pin	40p	99p
16pin	49p	106p
24pin	88p	178p
28pin	185p	290p
40pin	250p	255p

RIBBON CABLE
price per foot

		Grey Colour
10 way	15p	28p
16 way	25p	40p
20 way	30p	50p
24 way	40p	65p
28 way	55p	80p
34 way	60p	85p
40 way	70p	90p
50 way	85p	110p
64 way	100p	135p

**ZIF TEXTOOL
DIL SOCKETS**

24 pin	575p
28 pin	695p
40 pin	845p

'D' CONNECTORS miniature

	9 way	15 way	25 way	37 way
MALE				
Solder lugs	55p	80p	120p	150p
Angle pins	110p	175p	225p	300p
PCB pins	100p	100p	160p	250p
FEMALE				
Solder lugs	90p	125p	180p	275p
Angle pins	150p	200p	260p	390p
PCB pins	100p	125p	195p	355p
COVERS				
IDC 25way	75p	70p	70p	85p
'D' Plug Socket				

**25way 'D' CONNECTOR RS232
Jumper Lead Cable Assembly**

18" long, Single end, Male	495p
18" long, Single end, Female	525p
36" long, Double Ended, M/M	1025p
36" long, Double Ended, F/F	1050p
36" long, Double Ended, M/F	995p

**PANEL
METERS**
FSD
60 × 46 ×
35mm
0-50μA
0-100μA
0-500μA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"
475p each

CRYSTALS

32.768KHz	100
100KHz	545
200KHz	370
455KHz	370
1MHz	265
1.008M	275
1.28MHz	450
1.5MHz	525
1.6MHz	595
1.8MHz	545
1.8432M	230
2.0MHz	225
2.4576M	200
3.278M	150
3.5794M	96
3.6864M	300
4.0MHz	150
4.032MHz	290
4.194304M	200
4.433619M	100
4.80MHz	200
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.1441MHz	140
6.5536MHz	225
7.0MHz	150
7.168MHz	200
7.68MHz	200
8.0MHz	150
8.08333M	395
8.86723M	175
9.00MHz	150
10.0MHz	175
10.24MHz	200
10.7	150
12.0MHz	150
12.528M	300
14.31814M	170
15.0MHz	200
16.0MHz	200
18.0MHz	180
18.432M	150
20.0MHz	265
19.968MHz	150
24.0MHz	170
24.930MHz	325
26.69M	150
27.648M	170
27.145M	190
38.66667M	175
48.0MHz	170
100.0MHz	295
116.0MHz	250

RELAYS

Miniature, enclosed, PCB mount.
SINGLE POLE Changeover
RL6-91 205 Ω Coil; 12V DC (10V5 to 19.5 V). 10 A at 30 V DC or 250 V AC **185p**
DOUBLE POLE Changeover. 6 A
30 V DC or 250 V AC
RL6-100 53 Ω Coil, 6 V DC (5V4 to 9V9) **190p**
RL6-111 205 Ω Coil, 12 V DC (10V7 to 19V5) **195p**
RL6-114 740 Ω Coil, 24 V DC (22V to 37 V) **200p**

ASTEC UHF MODULATORS
6 MHz Standard 375p
8 MHz Wideband **550p**

BUZZERS, miniature, solid state
6V; 9V & 12V **70p**

PIEZO TRANSDUCERS
PB2720 **60p**

LOUDSPEAKERS
Miniature, 0.3W: 8Ω
2in, 3¼in, 2½in, 3in **80p**
2½in, 40Ω, 64Ω or 80Ω **80p**

MONITORS

- ■ Zenith – 12" Green or amber, Hi-Resolution Popular **£66**
- ■ MICROVITEC 1451, Med-Res, 14" Colour RGB input. Connecting Cable incl. **£237**
- ■ KAGA 12". Med-Res. RGB. Colour. Has flicker-free characters. Ideal for BBC, Apple, VIC, etc. **£225** (car.7)
- ■ KAGA 12". As above but Hi-Resolution **£310** (car.7)
- ■ Connecting Lead for KAGA **£5**
- ■ Carriage £7 securicor.

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A complete wordprocessing package consisting of BBC Micro, Zenith Green Hi-res Monitor, twin cased 200K Disc Drives, Wordwise, Watford's DFS interface, Brother HR15 Daisywheel printer, Database package, 10 Discs, all manuals and cables.
All you require is a mains power point to have it up and running.

Only: £1089

ANSFORMERS
3V; 6-0-6V; 9-0-9V; 12-0-12V; 15-0-15V
00 mA **130p**
mounting. Miniature, Split Bobbin
: 2 × 6V-0.25A; 2 × 9V-0.15A; 2 × 12V-A; 2 × 15V-0.1A **235p**
: 2 × 6V-0.5A; 2 × 9V-0.3A; 2 × 12V-0.25A; 5V-0.2A **280p**
ndard Split Bobbin type:
: 2 × 6V-0.5A; 2 × 9V-0.4A; 2 × 12V-0.3A; 5V-0.25A **250p**
A: 2 × 4.5V-1.3A; 2 × 6V-1A; 2 × 9V-0.6A; 2V-0.5A; 2 × 15V-0.4A; 2 × 20V-0.3A **345p** (35p p&p)
A: 2 × 6V-1.5A; 2 × 9V-1.2A; 2 × 12V-1A; 5V-0.8A; 2 × 20V-0.6A **385p** (60p p&p)
A: 2 × 6V-4A; 2 × 9V-2.5A; 2 × 12V-2A; 5V-1.5A; 2 × 20V-1.2A; 2 × 25V-1A; 0V-0.8A **480p** (60p p&p)
cially wound for Multirail Computer PSUs
A: Outputs +5V/5A; +12V, +25V, −5V, 2V at 1A **575p** (60p p&p)
VA: 2 × 12V-4A; 2 × 15V-3A; 2 × 20V-2.5A; 25V-2A; 2 × 30V-1.5A; 2 × 50V-1A
p p&p charge to be added over and abo- our normal postal charge).

VOLTAGE REGULATORS

1A	TO220 type		Plastic ve	Casting
5V	7805	50p	7905	50p
12V	7812	45p	7908	60p
15V	7815	45p	7912	50p
18V	7818	45p	7915	50p
24V	7824	45p	7918	50p
			7924	50p
100mA	TO92		Plastic	package
5V	78LO5	30p	79LO5	50p
6V	79LO6	30p		
8V	79LO8	30p		
12V	78L12	30p	79L12	50p
15V	78L15	30p	79L15	50p

ICL7660	248p	TAA550	50p
LM309K	135p	TDA1412	150p
LM317K	250p	78HO5 + 5V/5A	560p
LM317KP	99p	78H12 + 12V/5A	640p
LM323K	450p	78HG + 5V to +25V	
LM337	175p	5 A	585p
LM723 Var	30p	78S40	225
RC4194	375p	79HG 2.25V to	
RC4195	160p	24V 5A	685p

SOLDERCON PINS
Ideal for making SIL or DIL Sockets

100 pins	45p
500 pins	195p

ALUM BOXES

3 × 2 × 1"	65p
4 × 2½ × 2"	85p
4 × 2¾ × 2½"	103p
4 × 4 × 2"	105p
4 × 4 × 2½"	120p
5 × 4 × 1½"	99p
5 × 4 × 2½"	120p
5 × 2¾ × 1½"	90p
5 × 2¾ × 2½"	130p
6 × 4 × 2"	120p
6 × 4 × 3"	150p
7 × 5 × 3"	180p
8 × 6 × 3"	210p
10 × 4 × 3"	240p
10 × 7 × 3"	275p
12 × 5 × 3"	260p
12 × 8 × 3"	295p

MOS

		4070	25	4530	90
		4071	25	4531	130
	20	4072	25	4532	65
	25	4073	26	4534	400
	25	4075	25	4536	275
	70	4076	68	4538	80
	25	4077	25	4539	90
	60	4078	25	4541	95
	45	4081	25	4543	70
	45	4082	25	4544	150
	25	4085	60	4548	40
	25	4086	80	4549	400
	35	4089	125	4553	246
	60	4093	37	4554	190
	60	4094	70	4555	36
	40	4095	95	4556	55
	60	4096	100	4557	250
	60	4097	290	4558	120
	58	4098	80	4559	396
	80	4099	110	4560	160
	58	4160	95	4561	104
	67	4161	99	4562	350
	30	4162	99	4566	165
	50	4163	99	4568	250
	22	4174	99	4569	175
	90	4175	105	4572	45
	40	4194	105	4580	255
	50	4408	850	4581	125
	75	4409	850	4582	99
	35	4410	725	4583	100
	130	4411	750	4584	60
	70	4412	805	4585	60
	130	4415	590	4597	330
	140	4419	280	4599	155
	70	4422	770	40085	90
	275	4435	860	40097	45
	115	4440	999	40098	42
	110	4450	350	40100	215
	250	4451	350	40101	130
	60	4490	450	40102	140
	57	4500	675	40103	412
	50	4501	38	40104	120
	42	4502	60	40105	220
	50	4503	40	40106	60
	110	4504	99	40107	55
	60	4505	385	40108	325
	60	4506	100	40109	80
	55	4507	45	40110	235
	38	4508	130	40114	240
	35	4510	55	40161	194
	70	4511	55	40163	75
	60	4512	55	40174	75
	60	4513	150	40175	75
	85	4514	115	40181	220
	85	4515	115	40182	90
	85	4516	55	40192	75
	£10	4517	275	40193	70
	435	4518	48	40194	70
	68	4519	32	40195	75
	500	4520	53	40244	196
	995	4521	115	40245	196
	86	4522	125	40257	196
	45	4526	70	40373	220
	245	4527	85	40374	220
	25	4528	68	45106	596
	25	4529	150		

OPTO ELECTRONICS

LEDs with Clips	
TL209 Red	10
TIL211 Grn	14
TIL212 Yel.	14
TIL220 .2" Red	12
.2" Green, Yellow or Amber	14
0.2" Bi colour	
Red/Green	100p
Green/Yellow	115p
0.2" Tri colour	
Red/Green/Yellow	85
Hi-Brightness Red	59
Hi-Bri Green or Yellow	68
Flashing red 0.2" red	55
Square LEDs, Red, Green, Yellow	45
Rectangle Stackable LEDs	
Red, Green or Yell	18
Triangular LEDs	
Red	18
Green or yellow	22
LD271 Infra Red	46
SFH205 Detector	118
TIL32 Infra Red	52
TIL78 Detector	55
TIL38	50
TIL100	75
BARGRAPH, Red 10 segments	275

7 Segment Displays

TIL312 .3" CA	120
TIL313 .3" CC	120
TIL321 .5" CA	140
TIL322 .5" CC	140
TIL729/730	140
DL704 .3" CC	125
DL707 .3" CA	125
FND357 Red	120
FND500	130
.3" Green CA	150
.6" Green CA	215
.3" ± 1 Red CA	150
.3" ± 1 Green CA	150
LCD 3½ Digits	**495**
LCD 4 Digits	**530**
LCD 6 Digits	**625**

NEONS
Rectangular, nut fixing
Red, Amber, Green **30p**
REFLECTIVE Optical
Switch type TIL139 **225p**
SLOTTED Optical Switch
similar to RS Comp.'s **295p**

ISOLATORS

IL74	145
ILD74	145
ILQ74	275
TIL111/2/4	70
TIL117	125
4N33 Photo Darlington	135

OPTO

LS400C	255
OCP71	120
ORP12	86
ORP61	85
2N5777	45
BPX25	195
BPW21	295

AMPHENOL PLUGS

PLUGS (Male)	IDC	Solder
24 way IEEE	465p	460p
36 way Centronix	450p	475p
24 way Female	480p	450p
36 way Centronic Female	470p	500p

COMPUTER CORNER

- ■ EPSON RX80 Printer £209
- ■ EPSON RX80 F/T Printer £219
- ■ EPSON FX80 Printer £316
- ■ EPSON FX100 Printer £429
- ■ EPSON JX80 Colour Printer £525
- ■ KAGA/TAXAN KP810 Printer £252
- ■ KAGA/TAXAN KP910 Printer £339
- ■ BROTHER HR15 Daisywheel £329
- ■ Cable for above printers to interface with BBC Micro £7
- ■ TEX EPROM ERASER – Erases upto 25 Eproms. Has a built-in safety switch. £30
- ■ SPARE 'UV' lamp bulb £8
- ■ C12 Computer CASSETTES in Library cases 35p
- ■ 8½" & 9½" Fan Fold Paper (1000 Sheets) ..... £7 (Carr. 150p)

(Securicor Carriage charge on printers is £7)

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DRIVES CASED WITH PSU & CABLES

- ■ CS100 – TEC Single sided 40 track 100 K 5¼" Single Disc Drive **£119**
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- ■ CD400 – Epson Double sided 40 track 400K 5¼" TWIN disc drive **£215**
- ■ CD800S – MITSUBISHI double sided 80 track 800K 5¼" TWIN disc drives **£295**
- ■ DFS Manual (comprehensive) .... **£7** (NO VAT)
- ■ TWIN Disc Drive CASE with Power Supply to house your own Drives **£38**

N.B. All single drives with power supply will be supplied in a twin Case for later inclusion of a second Drive.

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- ■ 10 3M Diskettes Single side Double density **£14**
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N.B. Carriage on Drives (Securicor) **£7**

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6264LP – 150ns 8K RAMS **£8.95**

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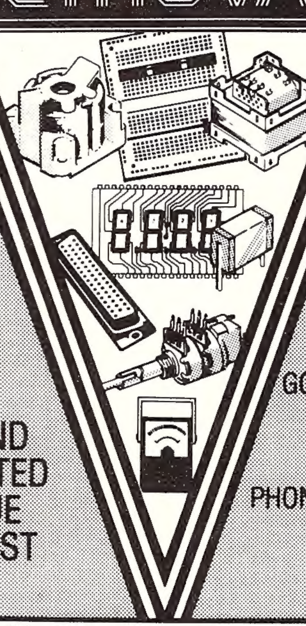

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ALPS FF317U FM FRONT END

Beautiful, precision made High Quality variable capacitor tuned FM Front End with Dual-gate MosFet. The tuning capacitor also has 2-AM Gangs and built in 3:1 reduction gear. Covers full FM range of 87 to 109 MHz. Supply needed is 12 V at only 30 mA Max. Inputs are provided for AGC and AFC signals. These have recently been on special offer from another supplier at £4 plus vat. OUR PRICE IS ONLY £3.99 INCLUDING VAT AND POSTAGE!. Circuit if required 35p

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The very latest amplifier design, published in 'Wireless World' by the renowned John Linsley-Hood. This may now be taken as the standard by which the rest are judged! Our kit, approved by the designer, has massive heat sinks and power supply and includes all components needed to build. Case size 412 mm wide, 254 mm deep and 145 mm high. Automatic switched speaker protection is included as standard Cost of all parts over £120. Our complete stereo kit price **£105.50.**

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Three band LW/MW/FM Stereo Tuner fully assembled on PCB 165 x 85 mm. Supplied with Ferrite rod aerial and band switch fully wired. Facility provided to drive tuning meter and stereo LED. Only needs 12 V DC supply. FM sensitivity. 2.5 uV. **Price only £7.99 inc. Vat and post.**

DGS001 2-MOTOR, SOLENOID CONTROLLED
CASSETTE DRIVE.

Fully solenoid controlled cassette mechanism suitable for Hi-Fi or digital use. With a logic control board the deck can be operated by lightweight touch controls or output from a micro. Ideal for applications under automatic control such as telephone answering machines, data loggers, automatic background music systems, remote control recorders and microcomputer program and data storage. Two motors and three solenoids control all functions including search in fast forward and rewind.
Standard fittings include reed switch for auto shut off, 3 digit counter, stereo R/P and erase Head.
Overall size 176 mm x 130 mm x 75 mm.
DGS001 Cassette Mechanism. **£37.25** Quantity prices on request.
INF140. Full technical specification and drawings **£1.**

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Due to a fantastic bulk purchase we are now able to offer the super SMV2012 varicap diodes at unbelievable prices. These are a wide range diode for use in AM tuner applications. They are also supplied in matched sets to eliminate tracking errors! Matched pair only **25p**. Matched 4 only **60p**.
AM TUNER COIL SET Set of 4 coils for long medium and short wave AM tuner. Coils are LW Osc, MW Osc, SW Osc and SW Aerial. Normally 30p each. OUR PRICE FOR THE SET **ONLY 55p**
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CASSETTE HEADS

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V E12 9p
IETAL FILM
TRASTABLE
4W EXTRA
OW NOISE
0 Ω to 1 MΩ
E24 3p
OW OHMIC
LAZE 0.5W
0 22WU to
8 2Ω
4 11p
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330Ω 29p
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andard Horiz 14p
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PRECISION
PRESETS
'E3 SERIES
Ω to 500K 99p

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100 V
DISC (PLATE)
E12 MICRO
MINI
TYPICALLY
± 5%
pF to 10nF 6p
OLYCARB 5%
SIEMENS
7 5 mm
MINIBLOC E12
250 V
nF to 6n8 8p
n2 to 47nF 9p
6nF to
50 nF 12p
100 V
00nF to 150nF 13p
80nF to 270nF 16p
30nF to 390nF 25p
70nF to 560nF 32p
80nF 38p
μF (10mm) 40p
POLYESTER
250V RADIAL
(C280)
0nF,15nF,
2nF,33nF,
7nF,68nF,
00nF 7p
50nF,220nF 10p
30nF,470nF 13p
80nF 18p
μF 22p
5μF 39p
2μF 39p
FEED
THROUGH
nF 500V 35p
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VOLTAGE
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stock

TANT BEADS

1/35V	14p
22/35V	14p
33/35V	14p
47/35V	14p
68/35V	14p
/35V	14p
2 2/35V	14p
3 3/35V	18p
4 7/35V	20p
6 8/35V	21p

10/16V	21p
10/35V	31p
15/16V	28p
15/25V	32p
22/6.3V	29p
22/16V	32p
33/10V	34p
47/3V	35p
47/6.3V	34p
47/16V	99p
100/3V	35p

ELECTRO
LYTICS
Mainly
Panasonic
AXIALS (Wires
each end)

μFd	V	
47	63	9p
47	100	10p
47	350	35p
1	100	10p
1	500	46p
2 2	25	9p
2 2	63	10p
2 2	100	13p
2 2	350	34p
3 3	40	13p
3 3	63	14p
4 7	35	10p
4 7	50	13p
4 7	63	14p
4 7	100	16p
10	25	9p
10	50	14p
10	63	16p
10	100	18p
10	350	55p
22	25	13p
22	40	16p
22	63	18p
22	100	24p
47	25	16p
47	40	20p
47	63	30p
47	100	32p
100	16	16p
100	25	18p
100	50	25p
100	63	29p
100	100	34p
220	10	18p
220	16	19p
220	25	25p
220	40	29p
220	63	34p
220	100	46p
470	16	25p
470	25	32p
470	40	38p
470	63	50p
470	100	69p
1000	16	34p
1000	25	43p
1000	40	53p
1000	63	75p
2200	16	53p
2200	25	71p
2200	50	80p
2200	63	1 54p
4700	16	87p
4700	25	99p

RADIALS
(Wires one
end)

μFd	V	
10	35	7p
22	10	7p
22	16	8p
47	10	8p
47	16	9p
100	10	10p
100	16	11p
220	10	13p
220	16	13p
470	10	14p
1000	10	23p
1000	16	28p
2200	10	39p
2200	16	51p
3300	10	57p
3300	16	75p
4700	10	75p
4700	16	1.09p
4700	63	2.99p
10000	16	2.99p
10000	80	4.95p

74TTL

7400	25p
7401	25p
7402	25p
7403	25p
7404	35p
7405	25p
7406	39p
7407	39p
7408	25p
7409	25p
7410	25p
7411	25p
7412	25p
7413	45p
7414	59p
7416	35p
7420	25p
7421	25p
7422	25p
7423	35p
7425	35p
7426	39p
7427	39p
7428	39p
7430	25p
7432	35p
7437	29p
7438	39p
7440	39p
7441	39p
7442	85p
7444	99p
7445	99p
7447	99p
7448	99p
7450	35p
7451	35p
7453	35p
7454	35p
7460	49p
7470	49p
7472	49p
7473	49p
7474	49p
7475	49p
7476	49p
7480	65p
7481	1.75
7482	95p
7483	95p
7484	95p
7485	95p
7486	39p
7489	1.99
7490	55p
7491	65p
7492	65p
7493	65p
7494	1 09
7495	55p
7496	55p
7497	1.99
74100	1 99
74104	49p
74107	15p
74109	69p
74110	1.99
74116	1.65
74118	99p
74119	1.79
74120	95p
74121	49p
74122	65p
74123	75p
74125	75p
74126	75p
74132	75p
74136	69p
74141	69p
74143	2 25
74144	2 25
74145	99p
74147	1 75
74148	1 29
74150	1 59
74151	65p
74154	1 39
74155	89p
74156	89p
74157	89p
74159	1.75
74160	1.05
74161	1.05
74162	99p
74163	99p
74164	99p
74165	1.05
74166	1.49
74170	1.79
74172	3.95
74173	1.45
74175	99p
74176	99p
74180	99p
74181	3 25
74182	1.35
74184	1 89
74185	1.89
74190	1.25
74192	99p
74193	99p
74194	99p
74195	79p
74196	1 19
74197	1 19
74198	2 25
74221	99p

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74LS11	24p
74LS12	24p
74LS13	32p
74LS14	49p
74LS20	24p
74LS21	24p
74LS22	24p
74LS27	24p
74LS28	24p
74LS30	24p
74LS32	24p
74LS33	24p
74LS37	24p
74LS38	24p
74LS40	24p
74LS42	49p
74LS47	85p
74LS51	24p
74LS54	24p
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74LS78	35p
74LS83	69p
74LS85	75p
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74LS90	49p
74LS92	55p
74LS93	55p
74LS95	75p
74LS107	39p
74LS109	45p
74LS112	45p
74LS113	45p
74LS114	45p
74LS122	69p
74LS123	85p
74LS124	1 35
74LS125	49p
74LS126	49p
74LS132	65p
74LS138	55p
74LS139	55p
74LS145	99p
74LS147	1 75
74LS148	1.35
74LS151	65p
74LS153	65p
74LS154	1 99
74LS157	55p
74LS158	69p
74LS160	75p
74LS161	75p
74LS162	75p
74LS163	75p
74LS164	75p
74LS165	1 09
74LS166	1 95
74LS169	99p
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74LS173	99p
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74LS181	1.99
74LS183	1.99
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74LS221	99p
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74LS241	85p
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74LS243	85p
74LS244	79p
74LS245	99p
74LS247	99p
74LS248	99p
74LS249	99p
74LS251	75p
74LS253	75p
74LS257	75p
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74LS259	1.19
74LS261	1.19
74LS266	55p
74LS273	1.22
74LS275	3 49
74LS279	75p
74LS280	1.89
74LS283	79p
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74LS293	79p
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74LS299	2.25
74LS323	3.09
74LS324	3 25
74LS325	1 65
74LS326	2.89
74LS327	2.89
74LS347	1.35
74LS348	1.95
74LS352	1.19
74LS353	1 19
74LS365	49p
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74LS367	49p
74LS368	49p
74LS373	95p
74LS374	95p
74LS378	95p
74LS386	49p
74LS390	79p
74LS393	1.09
74LS395	99p
74LS396	2 95
74LS398	1 95
74LS399	1 49
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4021	52p
4022	65p
4023	39p
4024	49p
4026	1 50
4027	39p
4028	47p
4029	75p
4030	35p
4031	1.25
4032	65p
4034	1.39
4035	95p
4036	2.75
4038	85p
4040	59p
4041	55p
4042	49p
4044	49p
4045	99p
4045	59p
4047	59p
4049	35p
4050	35p
4051	65p
4052	55p
4053	55p
4054	79p
4056	79p
4059	3 95
4060	65p
4063	85p
4066	39p
4067	2.25
4068	25p
4069	25p
4070	25p
4071	25p
4072	25p
4073	25p
4075	25p
4076	65p
4077	25p
4078	25p
4081	25p
4085	55p
4086	59p
4089	1 19
4093	35p
4094	69p
4095	89p
4096	89p
4098	79p
4099	99p
4103	1.95
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4507	35p
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4510	49p
4511	49p
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4515	1 05
4516	55p
4518	45p
4519	29p
4520	49p
4521	1 09
4522	79p
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4528	65p
4529	1.25
4532	65p
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LOGIC

CPUS

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6502A	5.45
6800	1 99
6802	2.49
6809	6 49
8035	5 49
8039	4 99
8035	ASK
Z80ACPU	2.95
Z80BCPU	7 95

MEMORIES

2114	2 50
2532 300N	3 49
2532 400N	3 45
2564	7 74
2708	2 99
2716	3 45
2732	4 35
2764 250	4 95
27128 250	6 14
4116 150N	1 25
4118	4 65
4164 150	3 96
6116	4.20
6810	1 55

MISC LOGIC

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ADC0816	20.80
ADC0817	12 54
SAA5000	4 05
SAA5010	7 81
SAA5012	7 81
SAA5020	5 95
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SAA5040	15.95
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SAA5070	18.95
8T26	1.09
8T28	1.09
8T95	1 09
8T97	1.09
81LS95	1 65
81LS97	1 65
81LS96	1 65
81LS98	1 65
6522	3 49
6522A	5 45
6532	5 25
6821	1 55
6840	3 75
6845	6 49
6847	6 49
8154	ASK
8155	ASK
8212	2 20
8216	1 60
8224	2 95
8226	2 95
8255	ASK
8271	53 00
Z80ACTC	2 99
Z80ADART	7 99
Z80APIO	3 19
ZN425E8	3.49
ZN426E8	7 99
ZN427E8	6 89
ZN428E8	4 55

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V REGS

Positive
100mA

78L05A	29p
78L12A	29p
78L15A	29p
78L24A	29p

1 Amp TO220

7805T	55p
7812T	55p
7815T	55p
7824T	55p

Negative
100mA TO92

79L05	49p
79L12	49p
79L15	49p

1 Amp TO220

7905T	65p
7912T	65p
7915T	65p
7924T	65p

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TRANSISTORS

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2N2219A	45p
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2N2222A	42p
2N2369	34p
2N2369A	35p
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2N2905	44p
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2N3053	45p
2N3054	98p
2N3055	65p
2N3055H	1 84p
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2N3440	99p
2N3441	1 55p
2N3442	2.05p
2N3553	2.95p
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2N4870	99p
2N4871	75p
2N5245	59p
2N5246	68p
2N5247	75p
2N5248	66p
2N5249	67p
2N5296	93p
2N5298	98p
2N5401	45p
2N5415	1 67p
2N5416	1.97p
2N5447	36p
2N5448	36p
2N5449	36p
2N5450	63p
2N5451	66p
2N5457	63p
2N5458	57p
2N5459	63p
2N5460	63p
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2N6126	1 72p
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2N6131	1 88p
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40250	1.95p
40361	75p
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40406	1 75p
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40410	1 99p
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40594	1 40p
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40871	1.15p
40872	1 15p
AC125	99p
AC126	35p
AC127	35p
AC128	39p
AC141K	39p
AC142K	39p
AC176	39p
AC176K	49p
AC187	39p
AC188	39p
AC187K	49p
AC188K	49p
AD161	55p
AD162	55p
BC107	16p
BC107A	17p
BC107B	19p
BC108	16p
BC108A	17p
BC108B	18p
BC108C	20p
BC109	17p
BC109B	18p
BC109C	21p
BC140	38p
BC141	43p
BC147	15p
BC148	15p
BC149	16p
BC157	39p
BC158	37p
BC158	44p
BC160	55p
BC161	59p
BC169	19p
BC169C	23p
BC177	29p
BC178	29p
BC179	31p
BC182	15p
BC182L	15p
BC183	14p
BC183L	15p
BC184	16p
BC212	16p
BC213	17p
BC213L	15p
BC214	18p
BC214L	19p
BC300	59p
BC301	59p
BC302	59p
BC303	59p
BC327	16p
BC394	52p
BC440	35p
BC441	37p
BC447	33p
BC448	33p
BC449	39p
BC460	38p
BC461	42p
BC478	38p
BC479	38p
BC546	16p
BC547	19p
BC548	16p
BC549	17p
BC550C	29p
BC557	19p
BC559	18p
BC560C	29p
BC639	37p
BC640	37p
BC650	45p
BC651	47p
BCY70	31p
BCY71	33p
BCY72	25p
BD131	63p
BD132	63p
BD135	38p
BD136	38p
BD137	39p
BD138	39p
BD139	42p
BD140	42p
BD237	98p
BD238	98p
BD239A	65p
BD239C	69p
BD240A	68p
BD240C	79p
BD241A	72p
BD241C	79p
BD242A	75p
BD242C	79p
BD243A	85p
BD243C	89p
BD2244A	88p
BD244C	1 15p
BD245C	1 19p
BD245C	1 49p
BD246C	1.67p
BD249A	2 30p
BD249C	2 57p
BD250A	2 48p
BD250C	2 75p
BD410	1.65p
BD419	1 45p
BD420	1 45p
BD433	69p
BD434	75p
BD435	81p
BD437	88p
BD438	88p
BD439	90p
BD440	91p
BD441	91p
BD442	93p
BD529	1 75p
BD530	1 95p
BD535	89p
BD536	89p
BD537	97p
BD538	97p
BD539	1.08p
BD540	1.04p
BD651	1.95p
BD652	1 95p
BD675	85p
BD676	87p
BD677	89p
BD678	99p
BD679	99p
BD680	1 35p
BD711	1 50p
BD712	1 50p
BDX32	3 90p
BDX33A	1 29p
BDX33C	1 59p
BDX34A	1 29p
BDX34C	1 59p
BDX66B	6 35p
BDX67B	6 35p
BDY54	2 28p
BDY55	2 39p
BDY56	2 23p
BDY57	6.38p
BDY58	8.97p
BF179	83p
BF180	46p
BF198	18p
BF199	18p
BF200	79p
BF244A	61p
BF244B	55p
BF245A	63p
BF245B	66p
BF246	77p
BF246A	79p
BF246B	79p
BF247A	79p
BF247B	79p
BF254	66p
BF255	68p
BF256A	59p
BF256B	59p
BF256C	69p
BF257	39p
BF258	41p
BF259	45p
BF457	48p
BF458	59p
BF459	65p
BF900	1.33p
BF961	2 10p
BFR90	2 25p
BFR91	2 75p
BFS61	65p
BFS98	27p
BFT66	2.75p
BFX29	44p
BFX30	46p
BFY50	36p
BFY51	36p
BFY52	36p
BSV81	2.65p
BSX19	29p
BSX20	33p
BSX21	49p
BU104	2 32p
BU105	1 89p
BU108	2 49p
BU109	2.49p
BU126	1.55p
BU204	2.49p
BU205	1.99p
BU206	2.16p
BU208	1.93p
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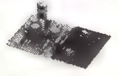

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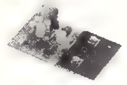

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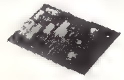

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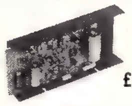

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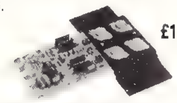

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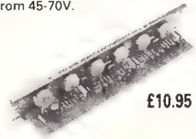

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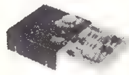

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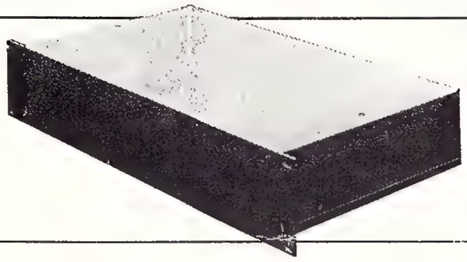

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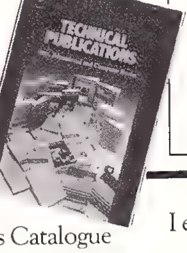

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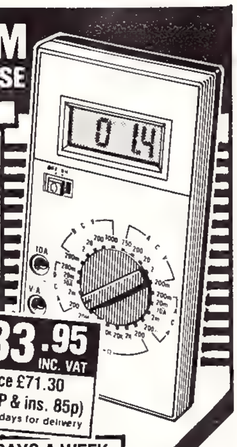

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1 8432MHz	240p	6 880MHz	240p
2 0000MHz	225p	8 000MHz	160p
2 4576MHz	225p	10 000MHz	170p
3 0000MHz	240p	16 000MHz	190p
3 5795MHz	120p	18 432MHz	150p
3 6864MHz	240p	19 6608MHz	240p
4 000MHz	150p	20 000MHz	200p
4 1943MHz	190p	27 000MHz	170p
5 0688MHz	240p	48 000MHz	170p

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EC911 0 189" Pads
EC940 0 016" Lines
EC941 0 031 Lines
EC942 0 039" Lines
EC943 0 049" Lines
EC944 0 061" Lines
EC945 0 079" Lines
EC946 0 100" Lines
EC947 0 124" Lines
EC950/1 0.031" 90° Bends
EC951/2 0.061" 90° Bends
EC951/1 0.031" 30°, 45°, 60° Bends
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EC960/1 TO-5 Transistor Pads
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500VA 42 × 26 × 19 cm
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Case Material heavy duty steel
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Carriage	£ 4.00

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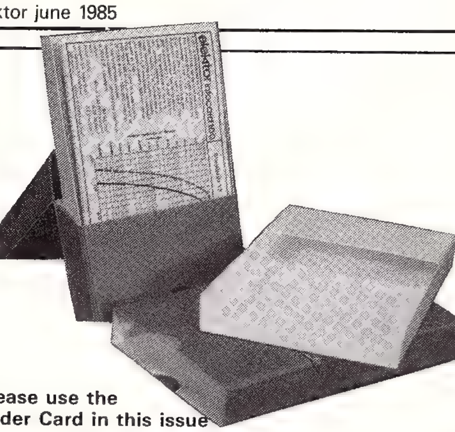

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elektor infocards

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- Screw connections for ease of installation
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HARDWARE KIT HW 1250

only £9.50 + V.A.T.

This attractive case is designed to house the control unit CA 1250, together with the appropriate LED indicators and key switch. Supplied with the necessary mounting pillars and punched front panel, the unit is given a professional appearance by an adhesive silk screened label. Size 200 x 180 x 700m

SIREN & POWER SUPPLY MODULE PSL 1865

only £9.95 + V.A.T.

A complete siren and power supply module which is capable of providing sound levels of 110dbs at 2 metres when used with a horn speaker. In addition, the unit provides a stabilised 12V output up to 100mA. A switching relay is also included so that the unit may be used in conjunction with the US 5063 to form a complete alarm.

NEW

TIMER SWITCH & POWER SUPPLY MODULE DP 3570 Price £13.95 + V.A.T.

The DP 3570 consists of an adjustable timer switch and stabilised 12V power supply for use in a wide range of applications including security, lighting control and automatic switching
The timer section of the module provides switching of loads up to 3A for pre-set times, the duration of which may be set by the user to between 10 secs and 5 mins. The timed period may be triggered by the opening of a loop or the closing of external contacts, with the timed period commencing instantaneously or delayed to provide a form of entrance delay.
The power supply section of the module provides a 12V output of up to 250mA which is sufficient for most applications The module operates from either 240V a/c supply or a 12V battery for which trickle charge facilities are included. Connections to the module are by means of screw terminal connectors with no soldering needed.

For mounting the unit an attractive moulded enclosure is available,

ME 357 only £2.85 + V.A.T.

INFRA-RED SYSTEM IR 1470 only £25.61+V.A.T.

Consisting of separate transmitter and receiver both of which are housed in attractive moulded cases, the system provides an invisible modulated beam over distances of up to 50ft operating a relay when the beam is broken Intended for use in security systems, but also ideal for photographic and measurement applications. Size 80 x 50 x 35mm

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- Adjustable range up to 25ft
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- 12V operation

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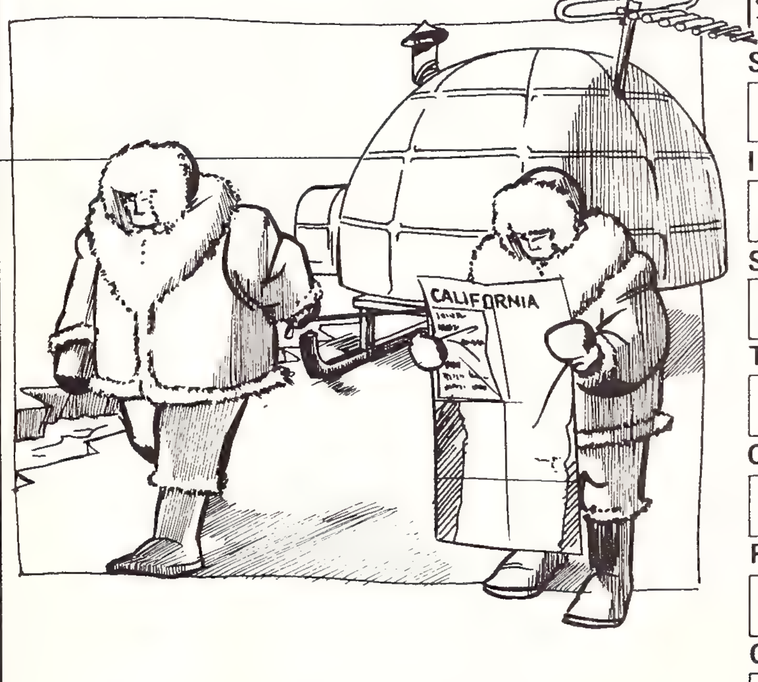

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NEWS VIEWS PEOPLE

Pilot aid

A cockpit panel-mounted moving map display system for the RAF's new GR5 Harrier aircraft has been developed by Ferranti Defence Systems of Edinburgh. The first production models are due for delivery in early 1986.

The system comprises three replaceable units: a panel-mounted moving map display, an interface unit, and a film strip ROM (read only memory). The moving map display is an analogue instrument similar to the pilot's display fitted to the Tornedo aircraft.

Parameters of the film strip are recorded in the ROM, which is a dedicated connector-type device plugged into the interface unit when the film is loaded. The interface unit enables the aircraft's digital navigation computer to obtain details of the film and then drive the map.

The display uses standard 35 mm film with a capacity for up to 17 metres of film. Typically, this length provides coverage of 100 nautical miles at scales of 1:1 000 000; 1:500 000; and 1:250 000.

(LPS)

Marconi success in Indonesia

In what is considered to be a major British sales breakthrough, Marconi Communication Systems Ltd has been awarded a contract by the Indonesian Navy to supply an integrated communication system.

The order, worth around £1 million, is for a fully integrated external and internal communication system specially designed to allow for expansion at a later date, and has been won against strong international competition.

The installation has been system engineered to include units of the Marconi ICS3, Seafox, and Makaira systems to provide a unique arrangement which meets the customer's requirements for the specific role of the ship.

INMOS healthy, says Thorn-EMI

Recent press suggestions of problems at its INMOS subsidiary have been countered by a brief statement from parent Thorn EMI. The board conceded that small losses had been incurred during the first quarter of this year, but said that internal forecasts continue to indicate a profit for the full calendar year. It said further that it was well known that the semiconductor industry was undergoing a difficult time at the moment. INMOS posted a £14.4 million net profit last year.

TV colour decoders

Brabury Limited is introducing the latest models in its MCM series of professional colour picture monitors at the 1985 Montreux Television Engineering Exhibition.

To obviate the need for special versions to suit scanning and colour standards, Brabury monitors are now available with fully automatic four-standard colour decoder units. These give immediate conversion to 625-line PAL or SECAM, or 525-line NTSC, or PAL-M as appropriate on receipt of the incoming video signal.

Also on show for the first time is the Brabury COMPACT, a portable self-contained video cassette display unit featuring a full 14-inch (350 mm) viewing screen. It is based on the Brabury MCM 37A colour picture monitor, with a built-in Panasonic N-180 video cassette unit that employs standard PAL VHS cassettes. The COMPACT contains its own sound channel and built-in loudspeaker.

Thick film exploitation

Swindon-based technology company BICC-CITEC Ltd has set up a new group to exploit its considerable experience in custom designed thick film products.

A wholly owned subsidiary of the BICC group, CITEC specializes in polymer and cermet thick film technology which it has applied to a broad spectrum of products for clients in industries as diverse as telecommunications, aerospace, automotive engineering, and consumer products.

Applied thick film projects already successfully completed include the design of position transducers for missile guidance, automotive vehicle fuel level and throttle position sensors, high voltage bleed resistors for television equipment, and power resistors for a range of consumer goods.

Pocket size success

Less than a year after the launch of the world's first practical pocket computer — the Organizer — it is selling well in Europe, the USA, Japan, and other parts of Asia, report London-based Psion.

The Organizer is already being used by Superior Inc., a specialist US sales training and instrumentation group, for recording personal and business expenses in line with the requirements of the Internal Revenue Service. In Britain it will be used to run till point validation on all charge card transactions carried out by Marks & Spencer. Wessex Publications of Beaminster is using the Organizer as a hand-held computer system for cost estimating in the building trade.

Psion has also devised a new application, Medipak, designed to aid doctors in prescribing drugs. The Medipak, used with a standard Organizer through a special keyboard template highlighting particular colour-coded keys, contains details of 280 commonly prescribed drugs with their cautions, side-effects, contra-indications, interactions, and safest alternatives.

(LPS)

Sky Channel for Luxembourg

Some 3000 television viewers in Luxembourg are now receiving ten hours of entertainment every day from Britain's cable TV station, Sky Channel.

Teledistribution Rene Klein — the first cable station in Luxembourg — takes Sky programmes and further cable stations are expected to begin transmitting shortly. By the end of the year, the number of homes receiving Sky Channel will have grown appreciably.

Established in October 1981, Sky Channel is the first cable TV station dedicated solely to home entertainment across Europe. Its programmes include drama, films, comedy, sports, documentaries, and pop music.

Sky Channel broadcasts for eleven and a half hours a day. It currently reaches over three million cable homes and hotels in the UK, the Netherlands, Switzerland, West Germany, Austria, Norway, Finland, Sweden, France, and Denmark. Sky Trax, the popular show featuring the latest pop videos and concert

footage, attracts an estimated nine million viewers from all over Europe each week.
(LPS)

Thorn EMI road show

Electronic engineers throughout the UK have been encouraged to use British digital recording techniques that are currently giving their US and European rivals a leading edge.
A series of seminars given by Thorn EMI Datatech at twenty different venues has spotlighted their SE9000 recorder and SE9500 formatter — two products that lead the world in the highly specialized and exclusive field of high-density digital recording (HDDR).
The recorder and formatter represent the state of the art in HDDR technology and have been acknowledged as world-leading in contracts from NASA and other US and European government agencies working at the forefront of technology.

Will SMAs eclipse PCBs?

Surface mounted assembly (SMA) of electronic equipment substantially reduces the size of circuit boards, and this can result in improvements in performance and reliability, especially if the circuit operates at high frequencies (because of smaller stray capacitances).
Conventional electronic assembly involves inserting the pins or leads of the components through holes in the printed circuit board (PCB) for soldering on its underside. In SMA there are no holes: the components — which themselves are much smaller than their conventional counterparts — are soldered direct onto pads on the printed side of the board.
One company that already provides a comprehensive service — from a feasibility study and design to production — involving this new technique is Circatech of Hereford.
(LPS)

NEWS
VIEWS
PEOPLE

Power control for Saudi Arabia

Harris corporation has been awarded a multi-million dollar contract to supply electric-power control systems to Saudi Arabia. The initial phase of the contract, valued at more than $7 million, included two Harris type 9200 power control systems to be installed at Bisha and Tihama in the southern region of Saudi Arabia, and some forty type 6000 remote terminal units. Each of the systems, which will control the generation, transmission, and distribution of electric power throughout southern Saudi Arabia, is based on two Harris type 800 minicomputers.

Cable TV marches on

A further step towards the "wired society" is being taken at Coventry, where test transmissions of multichannel cable television are being broadcast to trial customers.
Thorn EMI Cable Television, which owns Britain's first fully operational cable company at Swindon, is in partnership with British Telecom and a local company in the Conventry venture. As at Swindon. Coventry viewers will have the opportunity of seeing three Thorn EMI channels of films, pop music, and children's programmes, which also have growing audiences in western European countries where they are beamed to cabled homes via geo-stationary satellites 38 000 km above the earth.
Currently, eleven pilot projects for multi-channel cable transmission are underway in the UK, while franchise applications for five further areas are being considered.
(LPS)

Trident's Park Place

Park Place Investments has taken over fellow personnel specialists Trident Computer Services Group. Under the terms of the deal, the USM listed company is valued at exactly £2 million. Shareholders have been offered one Park Place share for every two held, which, with Park Place quoted at 160p, puts a value of 80p on each Trident share. Just prior to the announcement, the news of the possible take over caused Trident shares to rise 21p to 71p. Recently, Trident announced that profits for the six months to January were down 45 per cent at £125 000.

Not so elementary, my dear Watson!

Just over eighty years after the retirement of Sherlock Holmes, his namesake is again aiding police forces in their enquiries into murders and major crimes. The new HOLMES, acronym of Home Office Large Major Enquiry Systems, is a computer system developed by Burroughs Machines and Software Sciences. The system allows portable microcomputers to be used individually at the scene of the crime, in clusters at the nearest police station or temporary headquarters, or linked via minicomputer to other HOLMES systems throughout the country.
Every word entered into the system is automatically indexed by OFISfile, a purpose-built free text processor which is shipped to site or linked via telephone lines to a local microcomputer.
Efficient cross-referenced indexing is the key to all incident room police work. The traditional method with trays of hand-written cards has always been tedious, time-consuming work, and one misplaced card can negate hours of work or even wreck the investigation. With HOLMES, however, members of the incident room will be able to key in statement summaries and, on the microcomputer screen, highlight particular phrases, words, or factors.
Thereafter, any team member may recall the information direct or via word association/key phrase/commonality searching techniques.
The document and action management module will handle all the administration functions of the incident room procedure. It will track file documents, messages, telexes, etc., and, most importantly, keep a permanently updated record of all "actions" required of the team members.
(LPS)

Shortage of programmes for DBS?

Direct broadcasting by satellite (DBS) could become the linchpin of a system that links the high-definition television set, the digital sound hi-fi, the video cassette recorder, and the advanced home computer, according to Lord Thomson, chairman of the ITA, speaking at an international seminar on Cable Television and Satellite Broadcasting in London last March.
Lord Thomson also said that DBS provided a way of overcoming the shortage of frequencies as it gave the broadcaster, by international agreement, access to the 12 GHz band. The bandwidth available for DBS broadcasting not only took the

pressure off that part of the spectrum currently used by broadcasters, but allowed the development of ways of relaying increased amounts of information to the individual.

Mr Giles Shaw, Minister of State at the Home Office, pointed out that DBS would create several problems, particularly in the provision of television programmes. He reminded delegates that a European Commission had forecast that there would be a demand for 500 000 hours a year of fictional productions to fill available channels against a current production rate in the major European countries of 1000 hours a year.

(LPS)

Simulators for Finland

A contract to supply an air surveillance command and control simulator to the Finnish Air Force has been awarded to Marconi Data Systems, a division of Marconi Radar Systems Limited (MRSL) of Chelmsford.

The simulator, to be used for the basic and advanced training of radar observers and fighter controllers, as well as for air defence systems training, will be installed at the Finnish Air Force Communications School.

In this application, several combined primary/secondary radar heads running up to five exercises can be simulated simultaneously. Concurrent exercise preparation is possible thanks to the use of a powerful real-time operating system.

Marconi Data Systems is the sole supplier of this type of equipment to the Royal Air Force and many other Air Forces around the world.

Shop of the future

Thorn EMI Micrologic are doubling the size of their Kempston, Bedford, facilities to keep pace with current demand and technological advances. The extended factory is to include a British Electronic Point-of-Sale (EPOS) first: a Trial Shop where systems can be built, complete with software, and run to the customer's satisfaction before installation.

The Trial Shop will be manned by a team of youngsters working as if they were assistants in one of the High Street non-food multiples, where Micrologic currently leads the EPOS field with more than 3000 installations.

Micrologic is a Thorn EMI Information Technology company whose services range from site surveys to handling the electrical signal wiring. The company will even offer a service managing the connection of British Telecom lines.

That sinking feeling...

The troubled microcomputer market continues to be dismayed by gloomy reports from both sides of the Atlantic. One of the latest in the UK was Spectrum Group's disclosure of a trading loss for the six months to the end of last year. The announcement caused their shares to drop by about thirty-five per cent.

Spectrum blames their dismal performance on the price war in the home computer market and the high proportion of returned faulty products. The home computer business is notorious for its inordinately high returns rate.

Last June, Spectrum's shares stood at 130p and climbed to 143p in November, but since the beginning of this year they have been sinking gradually and now (April) stand at 50p.

In the USA, it is the suppliers to the computer industry that have been going down that slippery slope, because of over-capacity. Many companies continue to operate at a loss and the number of shut-downs is frightening: one of the more illustrious being Shugart, a subsidiary of the Xerox organization.

Putting the AXE in

British Telecom has placed a £100 million contract with Thorn Ericsson Telecommunications Ltd. The order is for AXE10 digital electronic local telephone exchanges to augment the modernization of BT's network. Thorn Ericsson is to start delivering 100 000 exchange lines in the second half of 1986 and to continue with 300 000 to 500 000 the following year. Thorn Ericsson is jointly owned by Thorn EMI and Telephone AB LM Ericsson.

Not the way to make history

Last April two men were charged in connection with alleged computer crimes. The men, from London and Sheffield, appeared in court under the *Forgery and Counterfeiting Act*. They are thought to be the first arrests of their kind in this country. Police have been investigating breaches of security in Prestel, the Britsh Telecom Viewdata system, since January.

Digital PAL decoder

The BBC and GEC-McMichael have signed a licence agreement for the manufacture of the BBC designed Digital PAL Decoder. This decoder takes a composite PAL colour television signal at the input and produces a digital bit-stream of red, green, and blue (RBG), and chrominance and luminance (YUV) information at the output.

Other outputs from this versatile decoder include digitally multiplexed YUV to EBU Parallel Interface Specification Tech 3246-E, and analogue RGB or YUV and mixed syncs.

Separation of the chrominance and luminance information is carried out by a combined vertical and temporal comb filter which totally suppresses fine cross-colour and gives some attenuation to coarse cross-colour and noise.

There are no operational adjustments and no routine alignment is required, since the performance is inherently stable through the use of digital processing techniques.

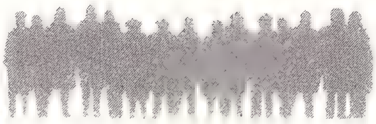
Package deal

Imhof-Bedco Standard Products Limited, the electronic enclosures division of Phicom PLC, has signalled its intention to extend its activities into the £25 million a year UK computer peripherals packaging market by signing an exclusive distribution agreement with Data Packaging Limited of Mullingar, Ireland.

Under the terms of the deal, a full range of plastic modular VDU consoles and keyboard enclosures manufactured by the Irish company will be available in the UK only through Imhof.

According to Imhof, the Data Packaging agreement is another step in its strategy of building out from its traditional market sectors through a combination of in-house product development and distribution agreements with major manufacturers. In the last year, similar deals between Imhof and German, French, and Spanish companies have been successfully completed.

NEWS VIEWS PEOPLE



This postman doesn't even ring once!

Teletex, Britain's launch pad for information technology, was taken into service in April. It is a new automatic high-speed message transmission service which sends a full page of text in a few seconds — thirty times faster than telex. It enables users to type ordinary letters, messages, and other documents on memory typewriters, word processors, or other computers and send them to similar equipment elsewhere, producing high-quality replicas of the original. Setting up calls, transmission, and reception will be fully automatic, without anyone having to be present at either end. British Telecom's primary role in the teletex service is to provide the networks. Customers have a telephone line to which their terminal is connected. Calls to another teletex terminal are made either over the ordinary telephone network or over Packet SwitchStream (PSS) — BT's public data network, depending on volume: heavy users may find PSS more economical.

Thorn(y) problem resolved

Electronics giant Thorn EMI has won a fifteen-year legal battle with Compagnie Francaise Télévision, CFT. The Court of Appeal dismissed CFT's appeal arising from an earlier High Court decision which also found in favour of Thorn EMI Ferguson. The French organization had claimed that the PAL colour TV system used in Britain, most of Europe, and large parts of the rest of the world, infringed their SECAM system. The decision of the Court lifts the threat of multi-million pound damages from Thorn EMI and other members of the UK television industry.

Revolutionary ear protector

Ear protection is essential when listening with headphones that could inadvertently be connected to an amplifier whose output levels are capable of causing hearing damage. There is also a need for a protector when listeners choose high listening levels with headphones, especially where there is much ambient noise. A revolutionary protector from the BBC's Engineering Designs Department is proving itself invaluable in use. The protector, which is smaller than a matchbox, protects the headphone wearer against harmful sound levels. Being powered from the audio signal, it needs no external power supply, and is wired into the lead between the headphones and the amplifiers. A further advantage it has over other limiters is that it does not distort the sound until the limiting level has been reached.

The limiting level is usually fixed on assembly to a value in the range from 95 to 110 dBA. An averaging network prevents the protector operating on short-term peaks. Similarly, a weighting network prevents the limiter acting on the less harmful low frequency sounds. The action of the averaging circuit means that, to allow for the dynamic range of the signal, the highest mean programme level that can be used is about 5 to 8 dB below the limiting level.

Hotel satellite TV successes

Following their introduction of a compact Satellite Television Receiver last January, Marconi Communication Systems have announced that TV Zagreb have signed a contract for this equipment. Another order is from the Beach Plaza Hotel in Monte Carlo. Negotiations are under way and further orders are expected as a result of these from a number of French and Benelux operators.

EUROMICRO 85

EUROMICRO 85 is the eleventh in a series of annual symposia organised by the European Association for Microprocessing and Microprogramming (EUROMICRO). Earlier events were held in Nice 1975, Venice 1976, Amsterdam 1977, Munich 1978, Gotenburg 1979, London 1980, Paris 1981, Antwerp 1982, Madrid 1983, Copenhagen 1984. Next year's event will be in Venice. This year's symposium will be held in Brussels from the third to the sixth of September 1985. It will follow the successful arrangements of the preceding symposia and will consist of a scientific program supported by tutorials and will also feature the Euromouse Competition finals, as well as the first competition for Robot Ping-Pong. The annual EUROMICRO symposium is the leading European forum concerned with microprocessor systems and microcomputers. It is a focus for the interchange of developments between university and industry. It attracts contributions as well as delegates from nearly all European countries, the United States and the Far-East.

The language of the symposium is English.

People

In recognizing the growing importance of high technology and marketing in the continuing development of their electronics and communications business world-wide, The Plessey Company PLC have recently appointed four senior executives to the Main Board of Directors. They are:

Professor John Bass, 55, the Company's Director of Research since 1980 and Managing Director of the Allen Clark Research Centre.

Mr. Vivian Butler, 51, Managing Director of the Engineering and Components Division since 1981, which includes the solid-state businesses of semiconductors and optoelectronics.

Professor William Gosling, 52, Technical Director of Plessey Electronic Systems Limited since 1981 and formerly Professor of Electronic Engineering and Pro Vice Chancellor at the University of Bath.

Mr Alan W Jones, 45, the Company's International Director since January this year and formerly Managing Director of the Displays and Sensors Division, including Plessey Radar.

Brendan Slamin, formerly the BBC's Chief Engineer, Regions, has been appointed Special Assistant to the Director of Engineering, undertaking the work of Project Director, Host Broadcasting Operation, for the 1986 Commonwealth Games in Edinburgh.

The new Chief Engineer, Regions, is George Pagan who since 1983 has been Head of Programme Services and Engineering at Pebble Mill, Birmingham.

electric motors, drives, and controls

Most electrical equipment has been affected by the boom in the electronics industry, and this is certainly true in the field of electric motors and their drives and controls.

The growing sophistication of electronic components is reflected in the improved performance of the equipment they are used to control. For instance, modern thyristors have a faster switching rate and higher peak inverse voltage ratings than their predecessors, giving greater security against spurious firing caused by voltage spikes on the circuits. This has helped to provide greater reliability in motor and drive systems.

Unreliability in the drives of the past was mainly caused by production techniques, which involved components being assembled by hand. Nowadays, however, most production of electronic printed circuit boards (PCBs) is carried out automatically, with the only human contact taking place during testing. Dry joints, which were probably the biggest single cause of failure, have now been virtually eliminated.

Flux solution

The flow soldering operation normally involves the application of flux solution beforehand. The flux becomes active at soldering temperatures and can then dissolve thin films of oxide from the surface of the PCB, from the component terminations and from the molten solder. But fluxes will not overcome poor solderability of boards and components.

Foam fluxing is presently the most commonly used application technique, involving the passage over a standing wave of foamed flux, produced by aeration from a submerged porous element.

Soldering may be carried out by simple flat dipping of the PCB assembly on to the freshly cleaned surface of the solder bath. One edge of the board is preferably brought into contact with the solder first and the other edge lowered slowly, to allow flux and solvent vapours to escape. When withdrawing the PCB assembly, an angled path is again used to help in draining the solder and removing "stalactites".

In wave soldering — the most popular current method — the solder is pumped out of a narrow slot to produce a standing wave, against the crest of which the PCB assembly passes on a conveyor. The conveyor is usually at an acute angle to the horizontal to assist in draining the solder, and double waves or special waveforms may also be used to accommodate long pins or uncropped component terminations.

No problem

Materials with good solderability ensure the capillary rise of the solder through plated holes, to make connections through to the component side when the solder side of the PCB is brought into contact with the molten solder. Penetration is improved by allowing the median plane of the PCB assembly to be level with the free solder surface, which generates a small but positive pressure to assist capillary action.

Multi-layer boards with internal ground planes may require a different depth to give good hole filling, owing to the thermal sink effect of such planes.

Although improvements in soldering techniques may have been the most significant factor in the achievement of the reliability that has made the electronic drive a viable product, it is by no means the only one. Further improvements are being sought by reducing the jointing problem, and this is done by putting as much of the control circuitry as possible on to integrated circuits. A look at recent products to enter the British market illustrates the inventiveness of the manufacturers.

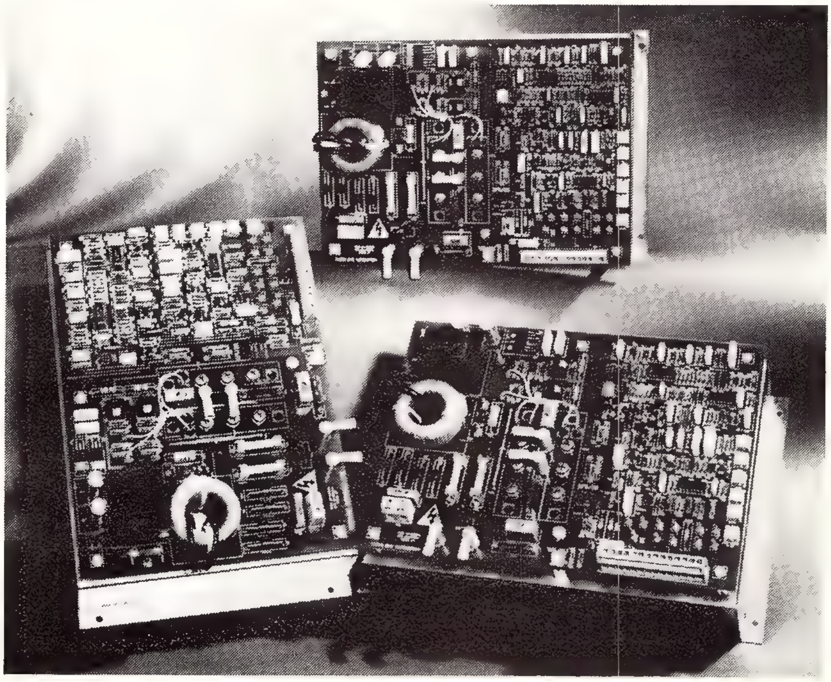
For instance, a new dc drive from Thorn EMI Automation has its own computer interface network in the drive power converter. This enables the drive controller to operate with any computer. The principal advantages of the distributed control facility offered by this drive are claimed to be reduced installation costs, system flexibility, and better diagnostics.

Local controller

It can also operate as a local machine controller with inherent intelligence for more advanced monitoring and communication with other equipment. This range of thyristor controlled dc drives offers controllers with ratings from 1 to 575 kW, in both non-regenerative and fully regenerative modes.

Another new product from the same company is a range of baby drives, offering three dc power converters for ratings between 1 and 9.3 kW. The range features groundable electronic circuits, adjustable ramp, and tacho or armature feedback. Fuseless operation, current limit control, minimum and maximum speed settings, and a trip output signal are also included.

Outputs from the three power converters are 7.5, 15 and 30 A. Each can operate from a 240 or 415 V supply. They are available in a boxed version with a miniature circuit breaker and a supply-on lamp.



The range of baby drives offered by Thorn EMI for ratings between 1 and 9.3 kW.

selektor

Six months development work by Power Semi-Conductors has produced a new range of open frame constructed, soft start motor controls. The 15LX, six pulse, solid state controllers are available in three versions, rated to 18.5, 45 and 75 kW at 380/440 V, 50 Hz, three phase. Acceleration of the motor can be achieved using open loop voltage control, closed loop current limit or tachogenerator feedback. LEDs indicate phase sequence, overload, full conduction, current limit, power supply on condition and firing circuit balance.

Auxiliary contacts

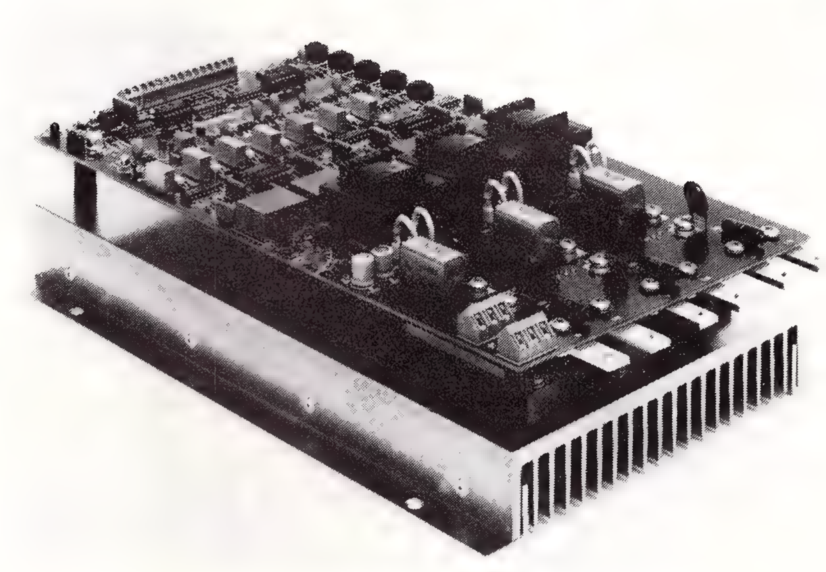
A line contactor is used for initiation of the control or, if required, auxiliary contacts can be used. An optically coupled triac fires at the end of the acceleration ramp, and its output can be used to interface with a bypass contactor.

The manufacturer claims this drive's design is unique, as it uses only four socket mounted integrated circuits throughout. The PCB is mounted directly on to isolated thyristor modules, allowing the heat sink to be chassis mounted without the need for insulating stand-offs.

New ac drives and ac brushless motors have recently been announced by Contraves Industrial Products. The company's multi-axis servo controller series is claimed to advance servo drive technology through the use of control circuits realised in thick film and integrated circuits, packaged in panel mounted modules. This range covers a continuous power range from less than 1 kW to 13 kW.

Six convection cooled modules and a matching power supply can be accommodated in a 432 x 355 mm panel space. Wiring is facilitated by plug-on terminal strips, and a plug-on "personality" card carries all servo compensation components and set-up adjustments.

Powertron permanent magnet ac servomotors from the same manufacturer are interchangeable with many ac and dc motors used on robotic and automated machinery. These rare earth magnet motors are available in four frame sizes, and each is made in two or three stack lengths and windings. The total of 24 models gives the robotics designer or machine engineer a choice of 12 rated torques between 1.3 and 56 Nm, maximum speeds from 1200 to 6000 rev/min, and motor diameters of 76, 102, 140, and 190 mm. They are available with two types of mounting, in British dimensions to NEMA and CEMA standards, and in metric dimensions to IEC72A and DIN standards.



One of the range of open frame, soft start, six pulse motor controls from Power Semi-Conductors.

Torque-to-weight ratio

Discodyn AC200 series servomotors, again from Contraves, have a disc-shaped rare earth magnet armature, and stator windings are mounted in a manner designed to give highly efficient heat dissipation. The company stresses the unit's high torque-to-weight ratio, short compact housing, thermal time constants from 30 to 50 min depending on motor size, low armature inertia, and theoretical acceleration as high as 35 000 rad/sec^2. All motors in this series have a rated speed of 3000 rev/min and are available in four frame sizes.

Also available are ac inverter drives designed for induction motor control systems up to 20 kW.

Microprocessor interface allows easy application to different motors and loads.

A new series of four quadrant motor speed controllers — the Series 460 — has been introduced by Simplatron, the controller section of Simplatroll. These controllers are said to be most suitable where accurate control ranges up to 1000:1 and current response times down to 15 ms may be required.

Greatest accuracy is attainable with a motor mounted tachogenerator rather than the armature voltage feedback method. Not only does the true dc voltage of the tachogenerator give the necessary accuracy of information on the direction and speed of the motor, but it keeps the controller circuits free of mains potential.

The secret of this controller's fast armature current reversal lies in the design of the switching method for the thyristor bridge. A permanent low value current circulates between the two thyristor bridges, enabling both to operate simultaneously — without damage to the thyristors — and hence faster. Earlier methods required sequential, and therefore slower, switching to avoid damage from short circuiting.

Quick reversing

This speed of switching offers operational advantages, including quick reversing and positioning of the driven machinery. Seven models are available with output powers ranging from 0.6 to 22 kW.

Applications involving unwind and rewind stands are especially suitable for this controller. Intermediate drives in processing lines also require this degree of control where the direction of rotation is fixed and fluctuating torque demand for speed holding may mean the controller has to alternate between negative and positive current values.

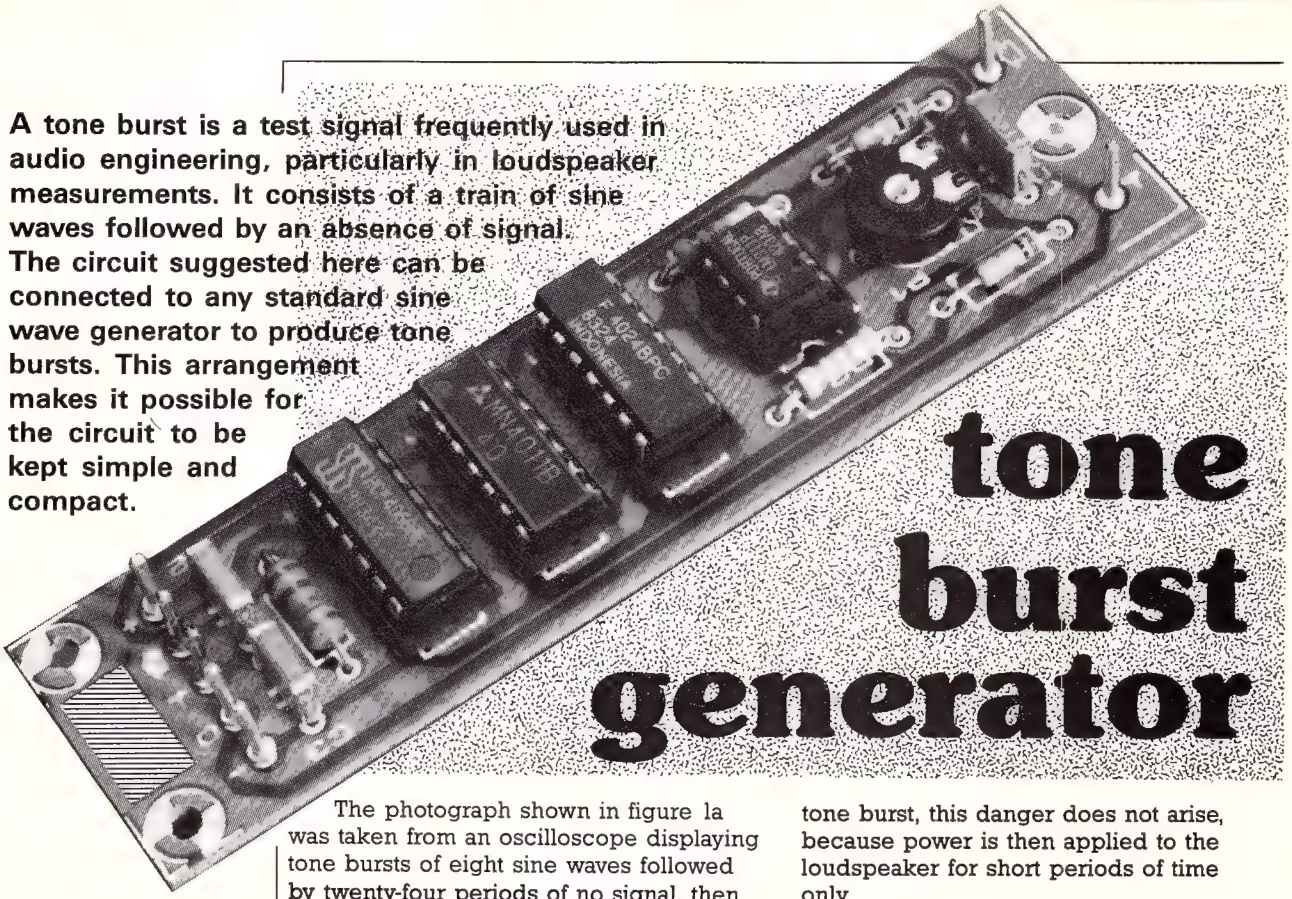
Solid state ac motor drives have recently reached the point where they are now competitive with dc drives for variable speed applications, largely due to the reliability and lower prices brought by automated manufacture. As prices for this type of equipment continue to fall, sophisticated drives will be justified in ever smaller installations.

(David Knott — LPS)

tone burst generator

counts the sine waves

A tone burst is a test signal frequently used in audio engineering, particularly in loudspeaker measurements. It consists of a train of sine waves followed by an absence of signal. The circuit suggested here can be connected to any standard sine wave generator to produce tone bursts. This arrangement makes it possible for the circuit to be kept simple and compact.



The photograph shown in figure 1a was taken from an oscilloscope displaying tone bursts of eight sine waves followed by twenty-four periods of no signal, then eight sine waves again, and so on. It is important to note that the first sine wave starts, and that the eighth sine wave ends, at a zero crossing. Fourier analysis shows that the complete signal contains integral multiples and submultiples of the fundamental sine wave.

In tests, a tone burst may be considered as a combination of a continuous sine wave and a stepped signal. This makes it possible for two parameters of a system to be measured: the sinusoidal response and the switching behaviour. It is illuminating to test an audio filter with a tone burst: it gives a new insight into the operation and quality of the filter.

As stated, tone bursts are used in testing loudspeaker systems. A tone burst and a measuring microphone make possible the precise observation of diaphragm vibrations. They also facilitate the measuring of the dynamic range of a loudspeaker (this is the region in which the cone, i.e., the diaphragm, reacts linearly to the applied input voltage). This can be a risky test without a tone burst, because the applied power may be so great that the loudspeaker breaks down. With a tone burst, this danger does not arise, because power is then applied to the loudspeaker for short periods of time only.

Circuit description

The sine waves are produced by a standard sine wave generator or a function generator. The circuit shown in figure 2 monitors the zero crossing of the sine waves and uses this information to determine whether the waves should be passed on to the output or not. This arrangement meets two requirements: the tone burst starts and ends at exactly a zero crossing; and the number of periods is constant irrespective of the sine wave frequency.

The input stage, IC_1, compares the input voltage with the potential at the wiper of preset P_1. Its output is a rectangular signal, the frequency of which is identical to that of the input signal. The off-set of the device, and the effects of a not quite symmetrical supply voltage, may be compensated with P_1. The 22 k resistor to the +9 V line is required because of the open collector output of the LM311.

The quadrangular pulses are applied to the clock input of counter IC_2. The logic level at the Q_3 output of this counter changes state every eighth period, and

1a

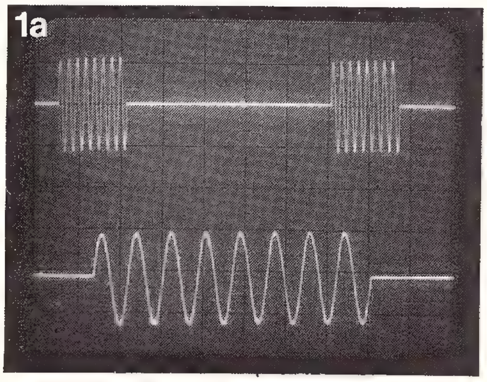


Figure 1a. A tone burst looks like this: at the top the complete signal; at the bottom, the sine wave only.

1b

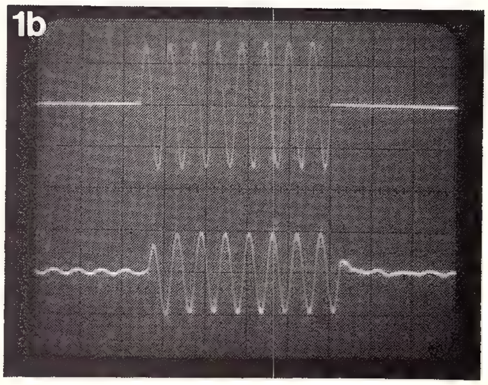


Figure 1b. Tone burst testing in practice: at the top the burst and at the bottom how this is reproduced by a good-quality mid-range loudspeaker.

2

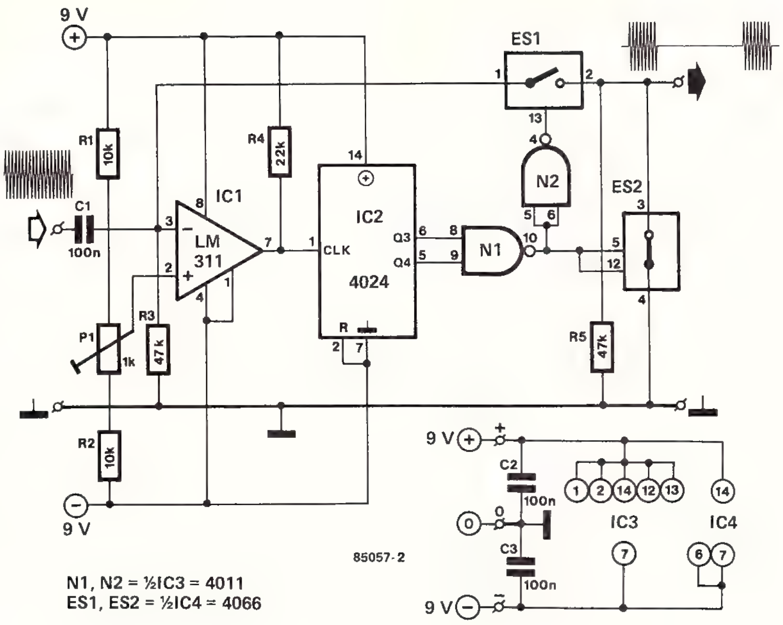


Figure 2. The circuit diagram of the tone burst generator.

Figure 3. Timing diagrams of the signals at various points in the circuit.

Figure 4. The printed circuit board of the generator is small enough to be built into an existing sine wave or function generator.

that at the Q_4 output every sixteenth period. Both outputs are applied to NAND gate N_1, so that the output of this gate is logic 1 for twenty-four periods, and logic 0 for eight periods. This signal is subsequently inverted by N_2. The wave forms at the various output terminals are shown in figure 3.

The outputs of N_1 and N_2 drive two electronic switches, ES_1 and ES_2. Because the control signal for ES_1 is inverted with respect to that for ES_2, these switches work in opposition. When ES_1 is closed (and ES_2 is open), the input signal is passed to the output. When ES_1 is open, the input signal is no longer passed to the output, while ES_2, which is closed, earthes the output. Resistors R_3 and R_5 ensure that neither the input resistance nor the output resistance is too high when ES_1 or ES_2 is open.

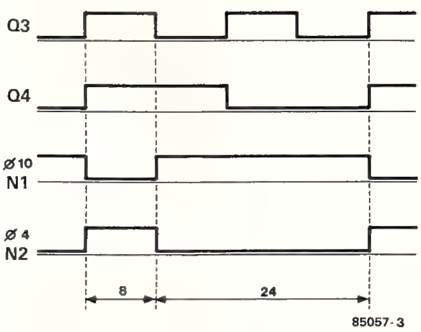
The circuit needs a symmetrical supply of ± 9 V, which must be well regulated, and is required to deliver a current of only 5 mA. It is important that the voltage does not exceed ± 9 V, because the CMOS ICs can stand only 18 V.

Construction and setting up

The tone burst generator is best built on the printed circuit board shown in figure 3.

Only potentiometer P_1 needs to be preset, for which an oscilloscope is required. Connect the generator to a ± 9 V power supply, the sine wave oscillator, and the oscilloscope. Set the output of the oscillator to 1 V_{pp} at a frequency of 1 kHz. Adjust P_1 so that the last sinusoidal cycle stops exactly at the zero crossing. If it stops too early, this is visible on the screen as a vertical line towards the zero crossing. If it stops too late, the sine wave will continue in a positive direction after the zero crossing. Once this point has been set correctly, the tone burst will also start exactly at a zero crossing.

3



Parts list

Resistors:
R_1,R_2 = 10 k
R_3,R_5 = 47 k
R_4 = 22 k
P_1 = 1 k preset

Capacitors:
C_1...C_3 = 100 n

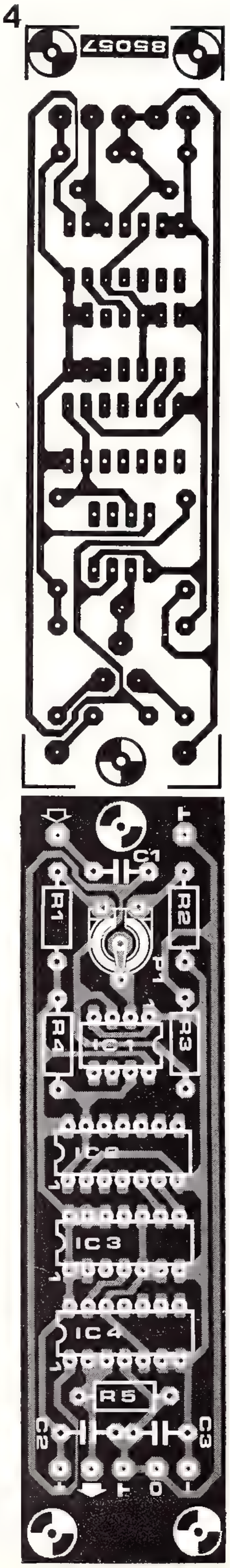
Semiconductors:
IC_1 = LM311
IC_2 = 4024
IC_3 = 4011
IC_4 = 4066

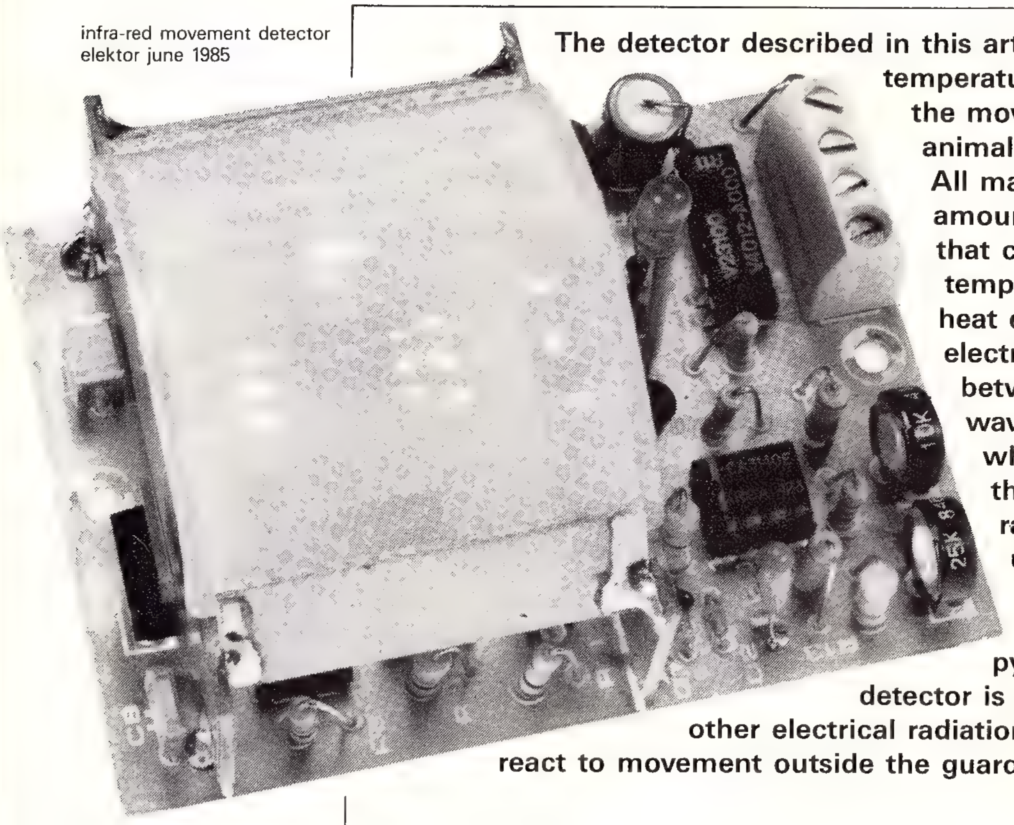
Finally...

Input capacitor C_1 blocks any direct voltage components that may be present in the sine wave generator output. When tone burst frequencies below 100 Hz are required, it is advisable to increase the value of the capacitor to 1 μF.

The signal to no-signal ratio of 8:24 in the present circuit may be altered by coupling different Q outputs of IC_2 to N_1. For instance, a ratio of 8:8 is obtained by disconnecting pin 5 of IC_2 (Q_4) from pin 9 of N_1 and connecting the latter to the +9 V line.

4





The detector described in this article reacts to fast temperature variations caused by the movement of people or animals in an enclosed space. All mammals radiate a certain amount of heat, and it is this that causes local variations in temperature. The radiant heat energy occupies the electromagnetic spectrum between light and radio waves, i.e., 0.74...300 μm, which is usually called the infra-red region. The radiant energy is picked up by a Fresnel lens, at the focus of which is a double differential pyroelectric sensor. The detector is largely unaffected by other electrical radiation. Also, it does not react to movement outside the guarded space.

infra-red movement detector

for use in intruder alarms

The Fresnel lens is named after the physicist A J Fresnel (1788-1827)

The space to be monitored is divided by the lens into a number of zones as illustrated in figure 1. The number of zones depends on the number of segments of which the lens is composed. When somebody moves from one zone into another, there is a change in temperature which is collected by the lens as a variation in radiant energy. At the focus of the lens is a pyroelectric sensor which reacts to such a change by generating a small electric signal. That signal is processed and used to actuate the alarm installation.

Lens or reflector

So far, we have spoken of the lens, but it is equally possible to use a Fresnel reflector, which is, however, much more difficult to obtain.

A Fresnel lens is composed of a number of smaller lenses so arranged that they give a very short focal length. Such lenses are used in headlights, spotlights, camera viewfinders, to name but a few.

Pyroelectric sensor

Pyroelectricity is the property of certain crystals, such as lithium sulphate, of developing (opposing) electric charges on opposite faces when the crystals are heated.

Infra-red intruder alarms invariably use dual element (=crystal) sensors. The elements, each measuring about 2×1 mm, are connected in series and in reverse polarity to each other at c. 1 mm intervals. These crystals are represented by two capacitors connected in opposition as shown in figure 4 — IR_1.

Any incident energy that crosses two elements sequentially causes positive and negative signals to be generated. The output signal will, therefore, vary over a wide range of peak to peak voltages.

Since the two crystals are of reverse polarity, any simultaneous incident energy on both elements causes no output signal, because the generated voltages negate one another. Dual element sensors therefore:

- prevent spurious operation caused by vibration;
- are highly resistant to variable environmental temperatures;
- prevent incorrect operation caused by external light sources, such as sun beams.

Apart from the two crystals, the sensor contains an n-channel field-effect transistor

1

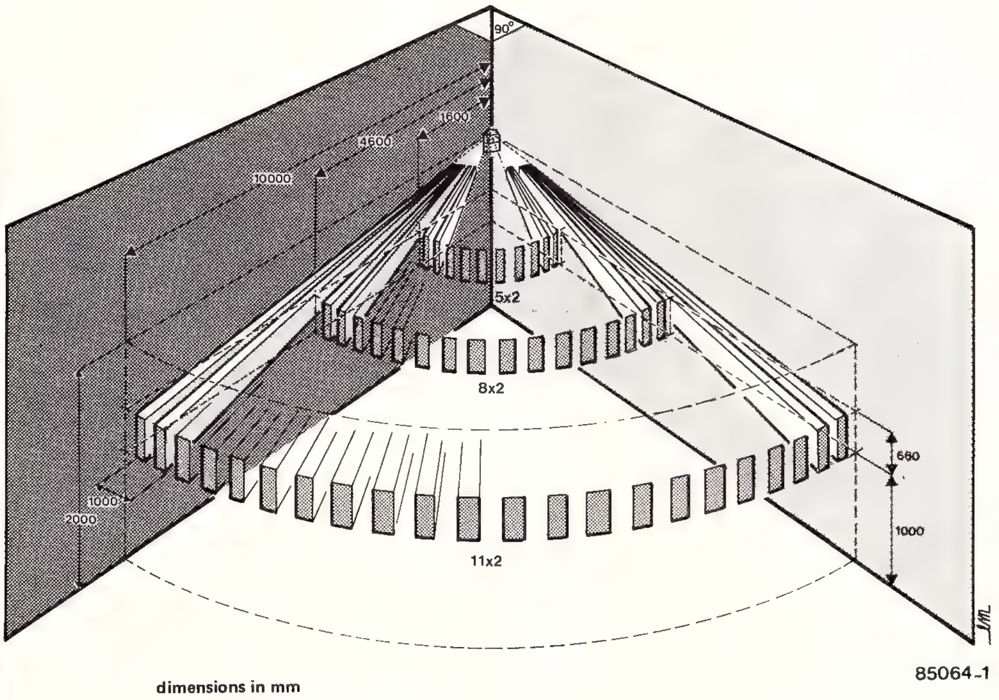


Figure 1. This illustrates the division of a space into zones by the Fresnel lens or reflector.

2

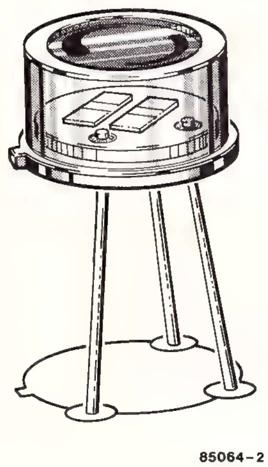


Figure 2. Infra-red sensor type RPY94.

(FET) and a non-linear element that protects the input of the FET against too high voltages. The FET has a very low noise factor and serves as preamplifier and impedance adapter. The entire sensor is contained in a TO-5 case which has a window for admitting the infra-red energy. Figure 2 shows a typical sensor, type RPY94, with open and closed case. A typical field of view diagram of this sensor is given in figure 3.
There are four different types of sensor suitable for use with the present circuit: their sensitivities are listed in table 1.

Circuit description

The signal generated by the sensor is taken from the source of the FET and

Table 1.

Type	Sensitivity V/W
SS02-CHK-1	500
IRA-E002SX4	115
RPY94	650
RPY95	450

3

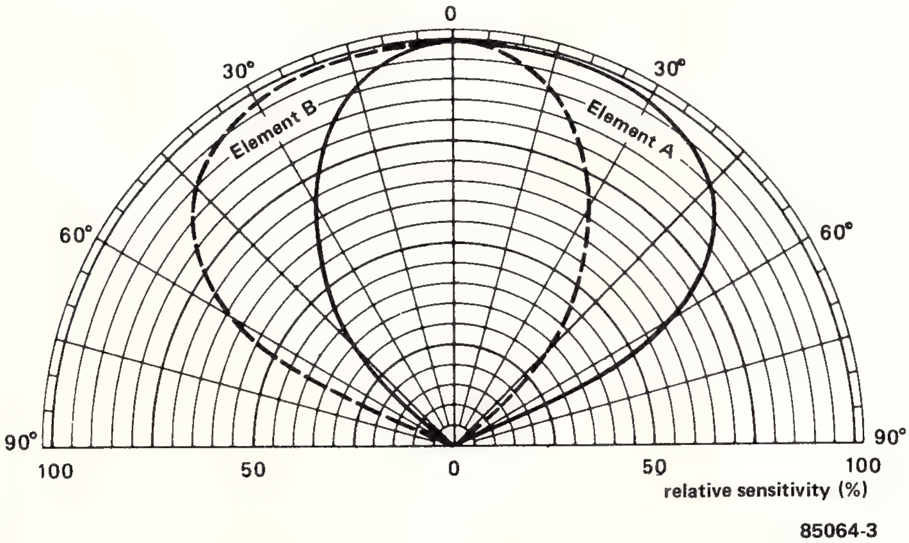
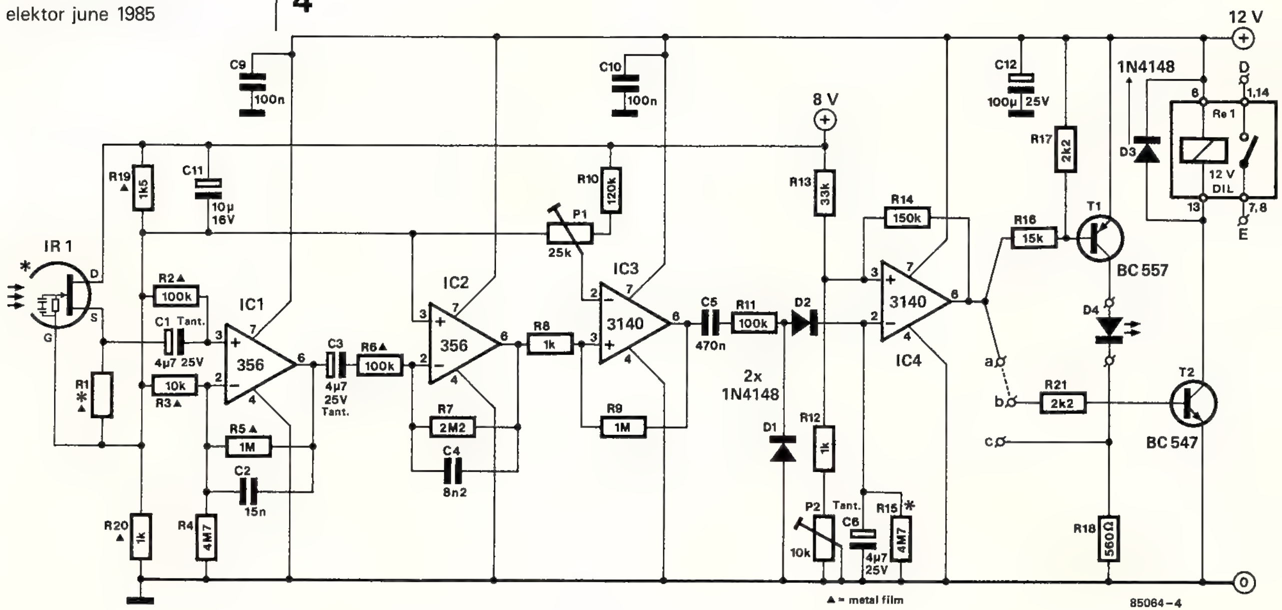


Figure 3. Typical field of view diagram in the *x-x* plane of dual element sensor type RPY94.

4



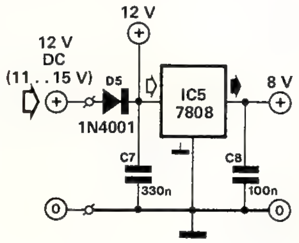


Figure 4. Circuit diagram of the infra-red movement detector.

coupled to the non-inverting input of IC_1 via capacitor C_1. This capacitor prevents signals with a frequency of about 0.3 Hz or less from reaching the input of IC_1. This opamp has an amplification of about 40 dB and cuts off frequencies above 10 Hz. Resistors R_1, R_2, R_3, R_4, and R_6 in the feedback network are all metal film types to ensure that the low noise factor of IC_1 is not negated.

The second amplifier, IC_2, is also configured to cut off frequencies above 10 Hz, and has an amplification of about 27 dB. As the amplifiers are operated from an asymmetrical supply, an auxiliary direct voltage is required for setting the correct operating point. This direct voltage of 3.2 V is provided by divider R_{19}—R_{20}. The inverting input of IC_1 is earthed via R_4 so that the output of the opamp is always a few hundred millivolts more positive than the negative terminal of C_3.

The signal from IC_2 is fed to Schmitt trigger IC_3, whose threshold is set by P_1.

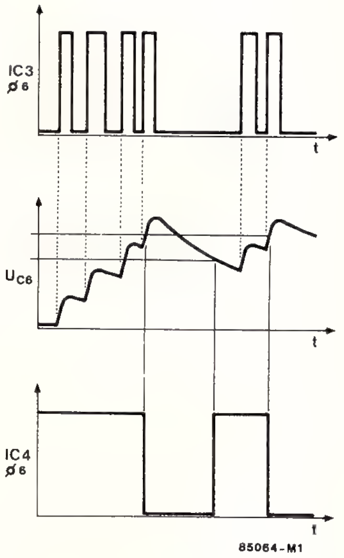
The trigger stage is followed by a diode pump consisting of R_{11}, C_5, C_6, D_1, and D_2. Every time the output of IC_3 goes high (+12 V), capacitor C_6 is charged via R_{11} and D_2, and at the same time discharged slowly via R_{15}. The charging current through C_6 is, therefore, shaped as shown for U_{C6} in figure 6. If IC_3 generates so many pulses that the voltage across C_6 exceeds the level preset by P_2, IC_4 toggles and its output goes low. Transistor T_1 then switches on and D_4 lights to indicate that there has been a movement.

The alarm may be actuated in two ways. If wire link a-b is closed, the low output of IC_4 cuts off transistor T_2, so that the relay is not energized. If, however, wire link c-b is closed, T_2 is switched on via T_1 and D_4, so that the relay is energized. It is, therefore, possible to have an open circuit or a short circuit at terminals D-E for setting off the alarm.

The circuit requires an operating voltage of 11...15 V: our prototype worked from 12 V. Current consumption is 25...30 mA, ignoring the relay and the LED, and some 80 mA with the relay energized and the LED lit.

Figure 6. Waveforms at a number of points in the circuit.

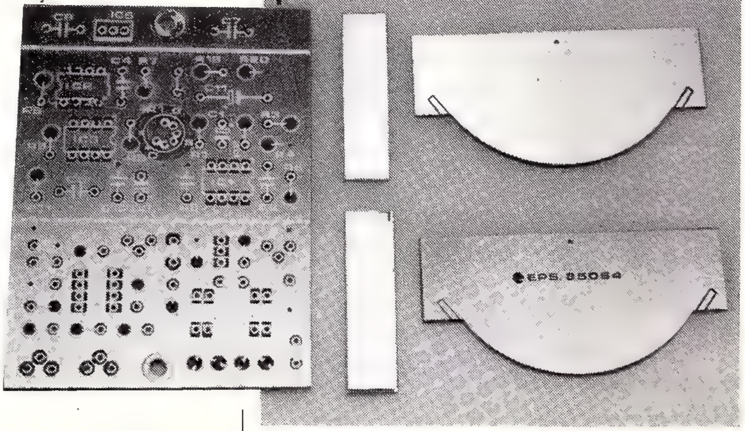
6



Construction

The circuit is best built on the printed circuit board shown in figure 5, which has been designed to provide the lens holder. First, cut the board as shown in photograph 1 — taking care that the copper

1



2

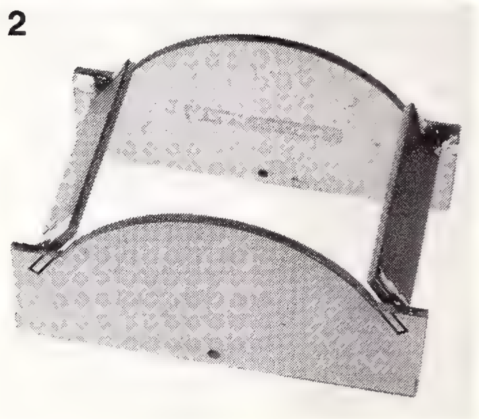


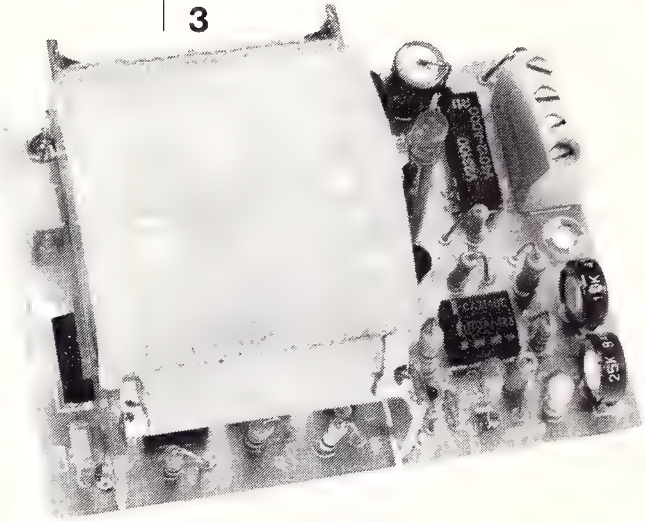
Photo 1. The sub-divided printed circuit board.

Photo 2. The structure of the lens holder.

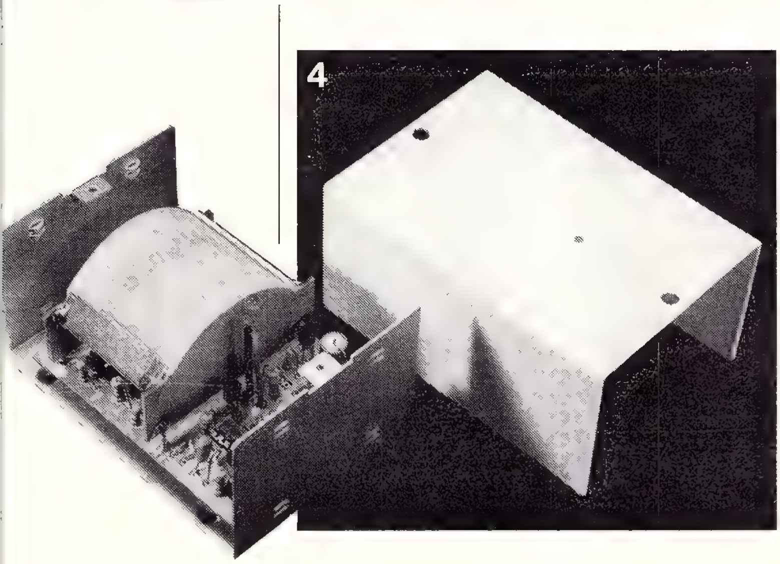
Photo 3. The completed board fitted with lens.

Photo 4. The finished detector.

3



4



tracks are cut cleanly. The first cut should be made along the dotted line. Next, the small rectangular piece should be cut out, and then cut into two. Finally, the half-round sections should be cut out, which is best done with a fretsaw. The four sections of the board are then soldered together as shown in photograph 2. This is facilitated by the small bars etched into the copper on the larger sections adjacent to the half-round parts. These bars indicate the exact position of the sections. Care should be taken during the cutting of the board not to saw into these bars! At a later stage, the lens is fitted into the resulting lens holder.

Next, the board can be wired up; first, of course, those components that are soldered at both sides of the board: R_4, R_{18}, R_{20}, C_6, C_9, C_{10}, C_{11}, C_{12}, and D_1. Then, the sensor should be fitted. These devices, like transistors, have a metal lip. When the SS02-CHK1 or the E002SX4 is used, this lip must point in the direction of IC_3; when the RPY94 or RPY95 is used, the lip should point to the 6 of R_6. Both situations are illustrated in figure 5. Soldering in of the sensor should be done quickly, because the device is heat sensitive. The sensor should be positioned roughly 5 mm above the board.

Before the lens is fitted, apply 12 V to the circuit and check that there is a direct voltage of about 3.2 V between the output of IC_2 and earth. This voltage should vary by $\pm$ 1 V when you move your hand close in front of the sensor.

The time has now come to fit the lens into place. First, solder four soldering pins into the four remaining free holes on the board. Then, slide the lens holder between the soldering pins into a position where the whole of the top of the sensor is visible through the centrally drilled holes in the sides of the holder. The lens holder is then soldered squarely onto the soldering pins. Finally, the lens is mounted into the holder with the line of segments pointing toward IC_5. If this has been done correctly, the lens is set at the proper angle.

The complete circuit should now be fitted into a small case, preferably of the type as indicated in the parts list. Before this is done, however, a hole the size of the lens should be drilled in the appropriate position in the lid of the case; this hole should be covered on the inside with a small piece (about 80 × 60 mm) of infra-red translucent window material. Also, two holes for adjusting the potentiometers and one for cable entry should be drilled in the appropriate places. Finally, the pcb is fitted into the case on two 15 mm insulated spacers.

Calibration

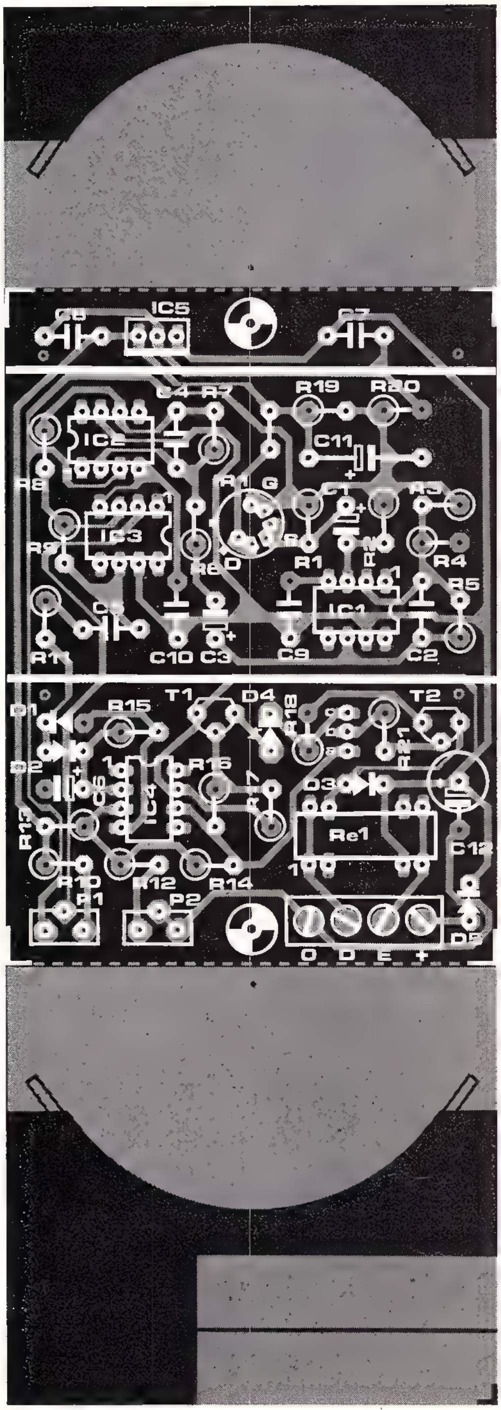
As already explained, IC_3 must deliver a number of pulses to ensure that C_6 is charged sufficiently to enable the alarm to be set off. How many pulses are required in a certain period of time depends on

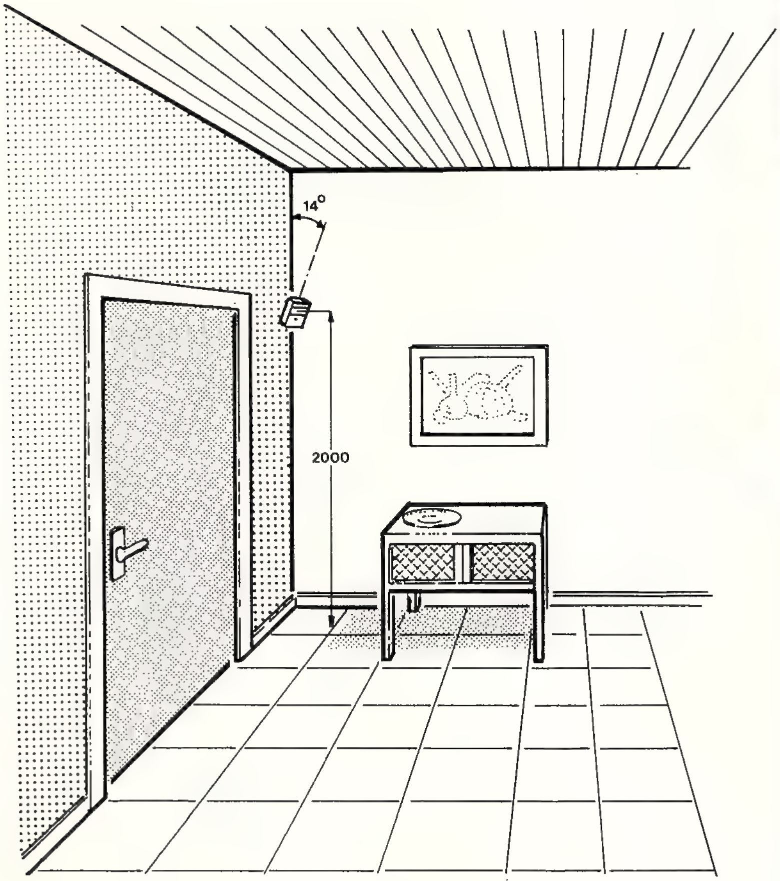
the setting of P_2 and on the value of R_{15}. The higher this value, the slower C_6 discharges: it keeps its charge longer and thus functions as a kind of energy store. With the value of R_{15} as in figure 4, i.e., 4M7, the time constant, $\tau = 22$ s. In this case, P_2 may be adjusted so that the alarm only goes off when at least five pulses are provided within fifteen seconds.
If you find that the circuit reacts too slowly, i.e., it is not sensitive enough, set P_2 to a lower value. At the same time, reduce the value of R_{15}, but this should not be taken below 470 k.
The setting of P_1 and P_2, as well as the value of R_{15}, is largely a matter of personal preference, but P_2 should not be set to its minimum value to avoid the alarm being set off by any small pulse. The diode pump ensures that no false alarms can be given.

Installation

The detector is best placed at a height of about 2 m (6 ft 6 in) at a downward angle of 14° from the vertical in a corner of the space to be guarded. It should not be placed in direct sunlight, nor above heating appliances. Our prototype has a reliable range of up to 12 m (39 ft). Remember also that the detector is not really suitable for use in open spaces.

5





Parts list

Resistors:
R_1* = see IR_1
R_2*,R_6*,R_{11} = 100 k
R_3 = 10 k
R_4,R_{15} = 4M7
R_5*,R_9 = 1 M
R_7 = 2M2
R_8,R_{12},R_{20}* = 1 k
R_{10} = 120 k
R_{13} = 33 k
R_{14} = 150 k
R_{16} = 15 k
R_{17},R_{21} = 2k2
R_{18} = 560 Ω
R_{19}* = 1k5
P_1 = preset, 25 k, vertical mounting
P_2 = preset, 10 k, vertical mounting
* = metal film type

Capacitors:
C_1,C_3,C_6 = 4µ7/25 V tantalum
C_2 = 15 n
C_4 = 8n2
C_5 = 470 n
C_7 = 330 n
C_8...C_{10} = 100 n
C_{11} = 10 µ/16 V
C_{12} = 100 µ/25 V

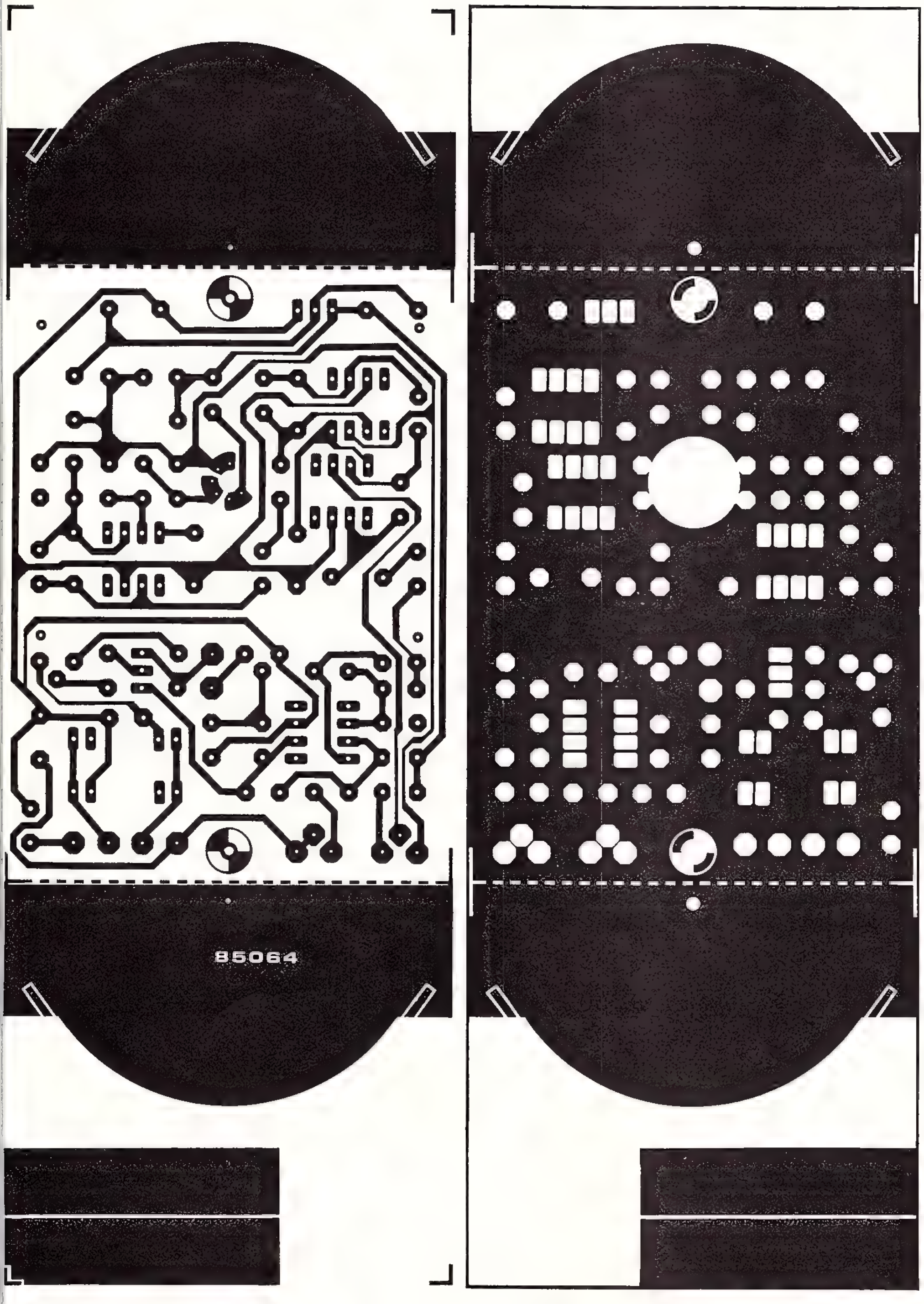


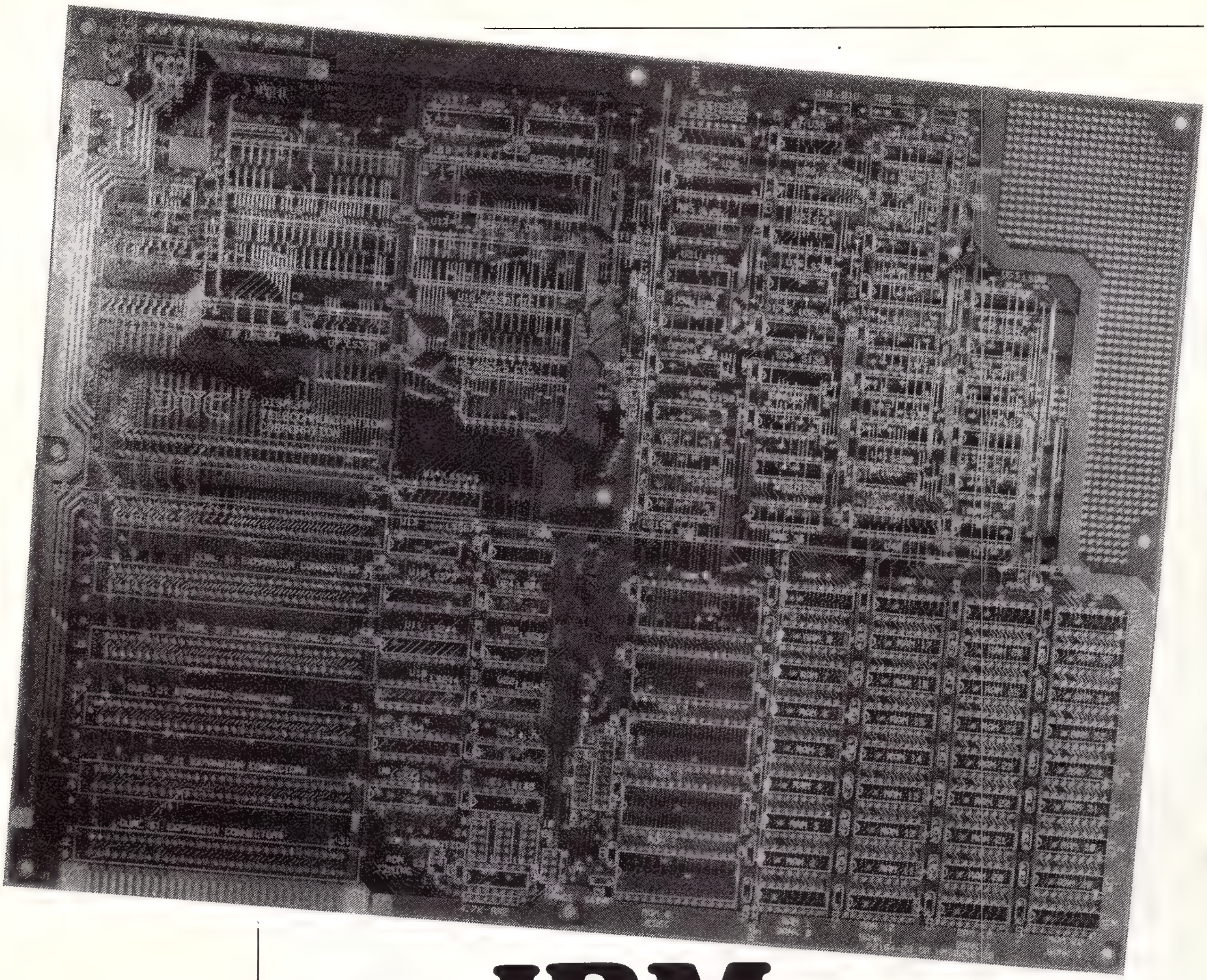
Figure 5. The printed circuit board of the infra-red movement detector.

Semiconductors:
$D_1 \ldots D_3$ = 1N4148
D_4 = LED, red, 5 mm
D_5 = 1N4001
T_1 = BC557
T_2 = BC547
IC_1,IC_2 = 356
IC_3,IC_4 = 3140
IC_5 = 7808

Miscellaneous:
Re_1 = relay, 12 V, DIL pcb type
IR_1 = SS02-CHK-1* (R_1 = 47 k)
IRA-E002SX4 (R_1 = 10 k) (Erie-Murata)
RPY94 or RPY 95 (R_1 = 22 k) (Philips/Valvo)
Fresnel lens type MSFL24*
Infra-red translucent window material, 80 × 60 mm*
Four-way spring-loaded terminal strip for pcb mounting
Case, 110 × 75 × 60 mm, Schyller type 93.210
available from:
Think Foremost Ltd
Nippors Way
Winscombe
Avon
Telephone (0934 84) 2429

Printed circuit board 85064

*Available from:
Chartland Electronics
Limited
P O Box 83
Cobham
Surrey
Telephone: (037 284) 2553
Telex: 263578 (chking g)



an IBM compatible micro

for home construction

As announced last month, we now publish the details of how to build yourself a first class personal computer. Note, however, that this is a project that should be tackled only if you have a fair amount of experience in electronics construction.

Our prototype is built partly from the Megaboard construction kit, produced by DTC (Display Telecommunication Corporation) of Dallas, Texas, USA, which is available from a number of specialist retailers.

It is advisable to strictly follow the *assembly instructions* supplied with the Megaboard kit. In addition, note the following points.

1) As the board is relatively expensive, it is wise to use IC sockets of prime quality.
2) A number of components are difficult to obtain; improvisation in some instances is, therefore, unavoidable. For instance,

- trimmer C_8 is a two-terminal type: it may be necessary to use a three-terminal type of which one of the two rotor terminals must be cut off;
- the resistance networks may be replaced by 1/8 W resistors: in our prototype RN_1 was replaced by 3×4k7, RN_2 by 5×4k7, RN_6 by 7×33 Ω, and RN_7 by 7×33 Ω.
- delay line TD_2 has such a short delay time (7 ns) that we just replaced it by a wire link;
- some of the jumper connections for the EPROM selection are angled: these may be made from a piece of double-pole connector strip;
- jumper connection 1-3 is wrong — this jumper should interconnect terminals 2 and 3.

3) We found the instruction on how to place the shorting plugs for the EPROM

decoding somewhat vague; note, therefore, that the stated connections only apply to 2764 type EPROMs. Wire link 5-6 at E_8 is superfluous, as is 5-7 at E_9. Also at E_9, wire link 13-14 should read 14-15.

4) When the board is wired up, but before the ICs are inserted into the relevant sockets, it is best to check it with a 5 V supply and a voltmeter for any short circuits or missing connections.

5) At ths stage, the ICs can be placed into the appropriate sockets. Most ICs are fairly conventional types, but the PROM, U_{43}, the 100 ns delay line, TD_1, and U_{47} are not often encountered.

6) If you are using the Megaboard kit, you either have a ready-programmed PROM, or you do not need one (in case of the Super XT/PC Board to which we will revert later). If you are doing your own programming, note that Toshiba's 24S10 may be replaced by Harris's HM7611, MMI's 9301-1, or Fairchild's 93427. The hexdump of the program can be found on page 20 of the IBM PC manual, the RAM sub-system is described on page 18, and on page 19 is shown which wire links must be placed at E_{11} for the various RAM ranges (these are not stated in the *assembly instructions*).

What has to be done at E_{12} can only be seen at the track side of the board, which (not shown on the circuit diagram) has already been provided with the appropriate connections.

A wire link has to be placed across terminals 1-2 of E_{11}: here again, this is not mentioned anywhere.

Delay line TD_1 is best replaced by the auxiliary circuit of figure 2, in which all eight driver stages have been cascaded, so that the propagation delay times of the gates provide the required delay. The encircled figures on the periphery correspond to the pins of TD_1; the others are the pin numbers of the 74LS241. The practical construction of the circuit is illustrated in figure 3. Although the measured delay time is a little shorter than theoretically predicted, our prototype functioned without a hitch.

If you have difficulties obtaining the 75477 for the U_{47} position, you can use a field-effect transistor type BS 170 or VN10KM, connected as shown in dotted lines.

2

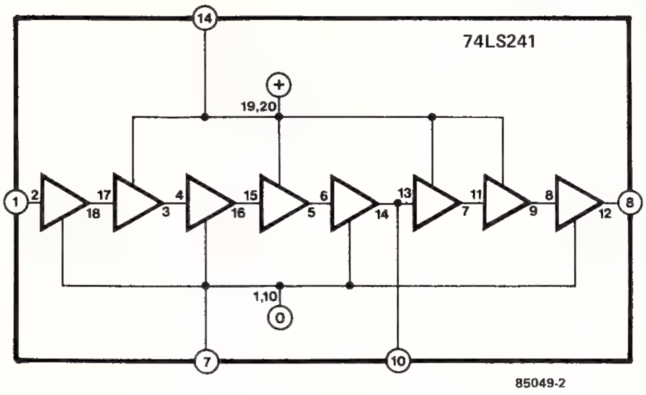


Figure 2. Delay line TD_1 may be replaced by this simple circuit.

Power supply

For convenience's sake, we have used the *microcomputer power supply* previously published in the July/August 1984 issue of *Elektor* — p. 7-52. This design can be modified as shown in figure 5: the —5 V can be omitted because the DRAMs do not need a symmetrical supply. As the 12 V section can provide up to 3 A, it is possible to use extension boards equipped with internal 5 V regulators.

1

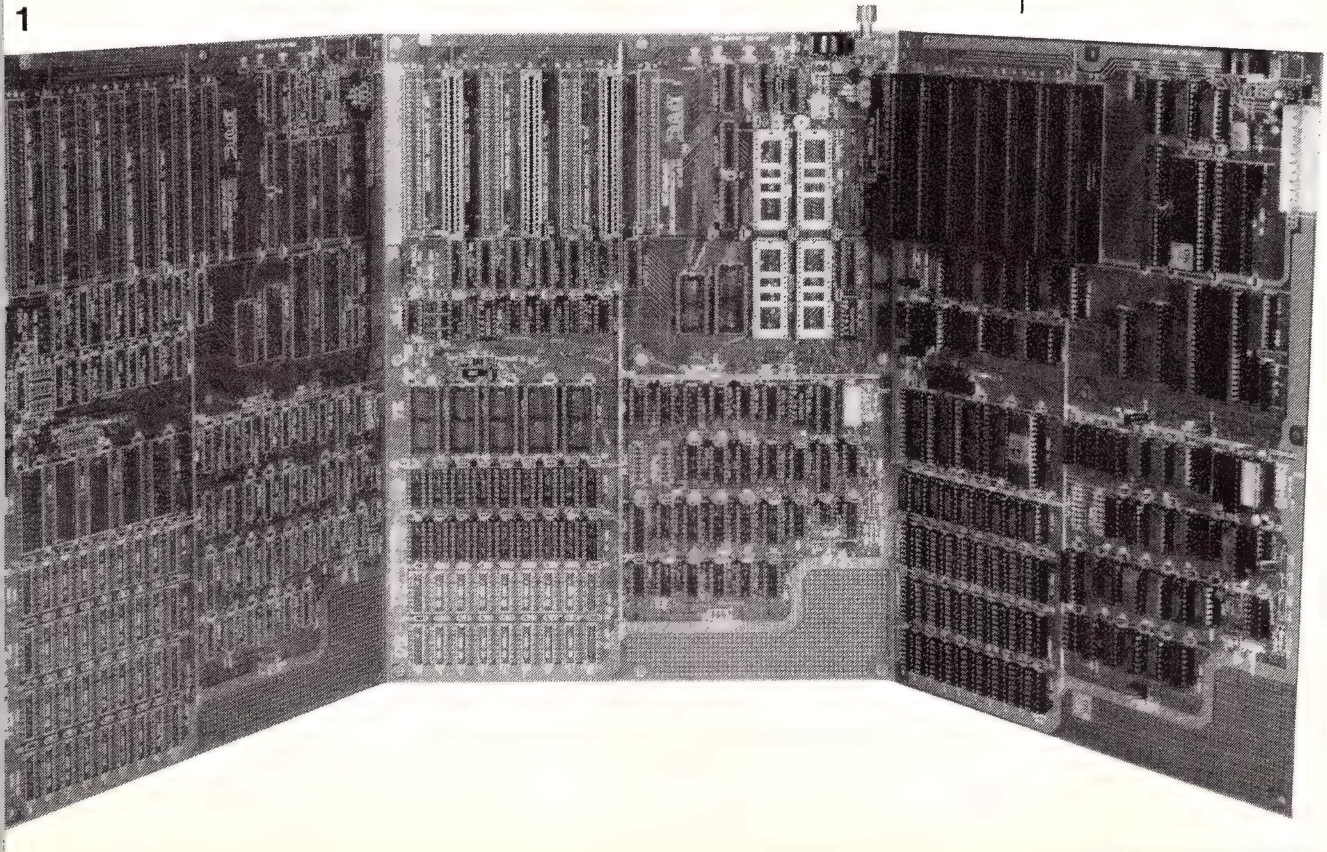


Figure 1. Three mother boards: a virgin, a partly built, and a fully constructed model.

3

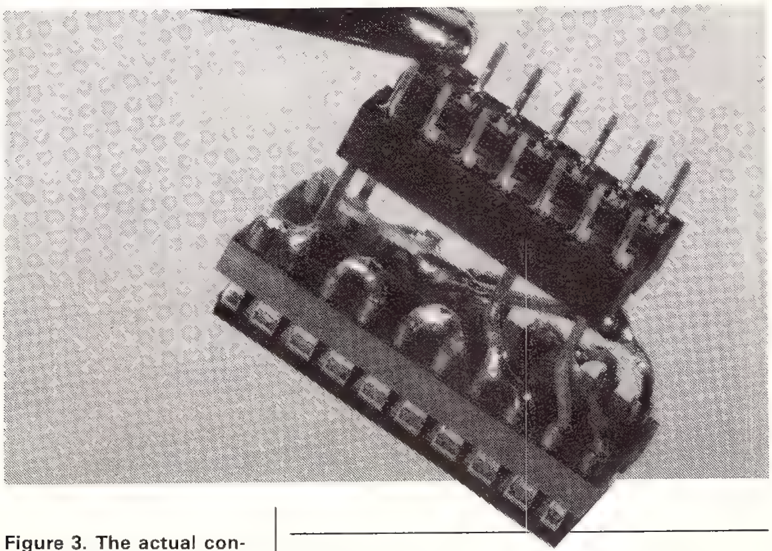


Figure 3. The actual construction of the circuit in figure 2.

Even then, there is sufficient power in reserve for the motor of a Winchester disk drive.

Adequate cooling of the power transistors is imperative; we have mounted them on a generous heat sink, so that thermal problems will not be encountered.

Furthermore, we have added the *microcomputer power supply protection* circuit originally published in the July/August 1984 issue of *Elektor* — p. 7-93 in somewhat modified form as shown in figure 7. The modification consists of S_2 being replaced by a wire link and placing a push button switch in series with a 1 k resistance across D_3. The function of the new switch is to ensure that the 12 V line is always switched off before the 5 V line, so that the read/write head of the drives can never be loaded uncontrolled at switch off. This measure is not strictly necessary with modern drives, because these are normally already provided with this protection. However, if you are not sure, or you have an older drive mechanism, it is safest to fit the switch!

The original printed circuit board of both the power supply (84477) and the protection circuit (84408) can be used without modification.

Intermediate test

The EPROM containing the BIOS (basic input output system) also has some self-test routines with which the operation of the mother board can be checked.

First, however, we advise you to thoroughly test the power supply before connecting it to the mother board: we tested ours with resistive loads for 15 hours, but in your case, two hours should do nicely. Once that has been completed satisfactorily, the supply can be connected to the board. Then, contacts SW_1 and SW_2 of the DIL switch on the board should be closed (=on=logic 0), which indicates to the MEGA BIOS that there is no arithmetic processor present, and that a RAM test need not be carried out. If the latter were omitted, the test program would try to test the RAM on the video card, and, of course, there is no RAM as yet.

If everything is in order, the loudspeaker should emit a short high frequency tone some seconds after the supply has been switched on, and also when the reset switch is pressed.

After that, it is best to follow the *Testing and Debugging* instructions. However, in our experience, neither a 100 MHz oscilloscope, nor a logic analyser is necessary; a 10 MHz scope is perfectly adequate.

4

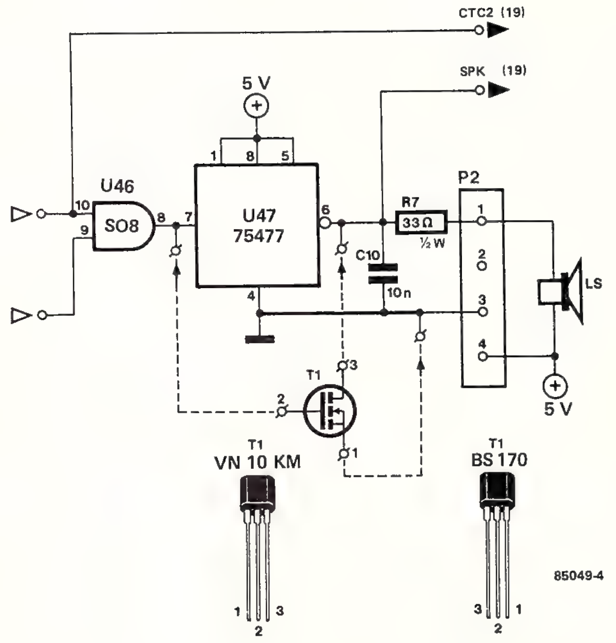


Figure 4. The type 75477 IC in the U_{47} position may be replaced by a MOSFET as shown.

5

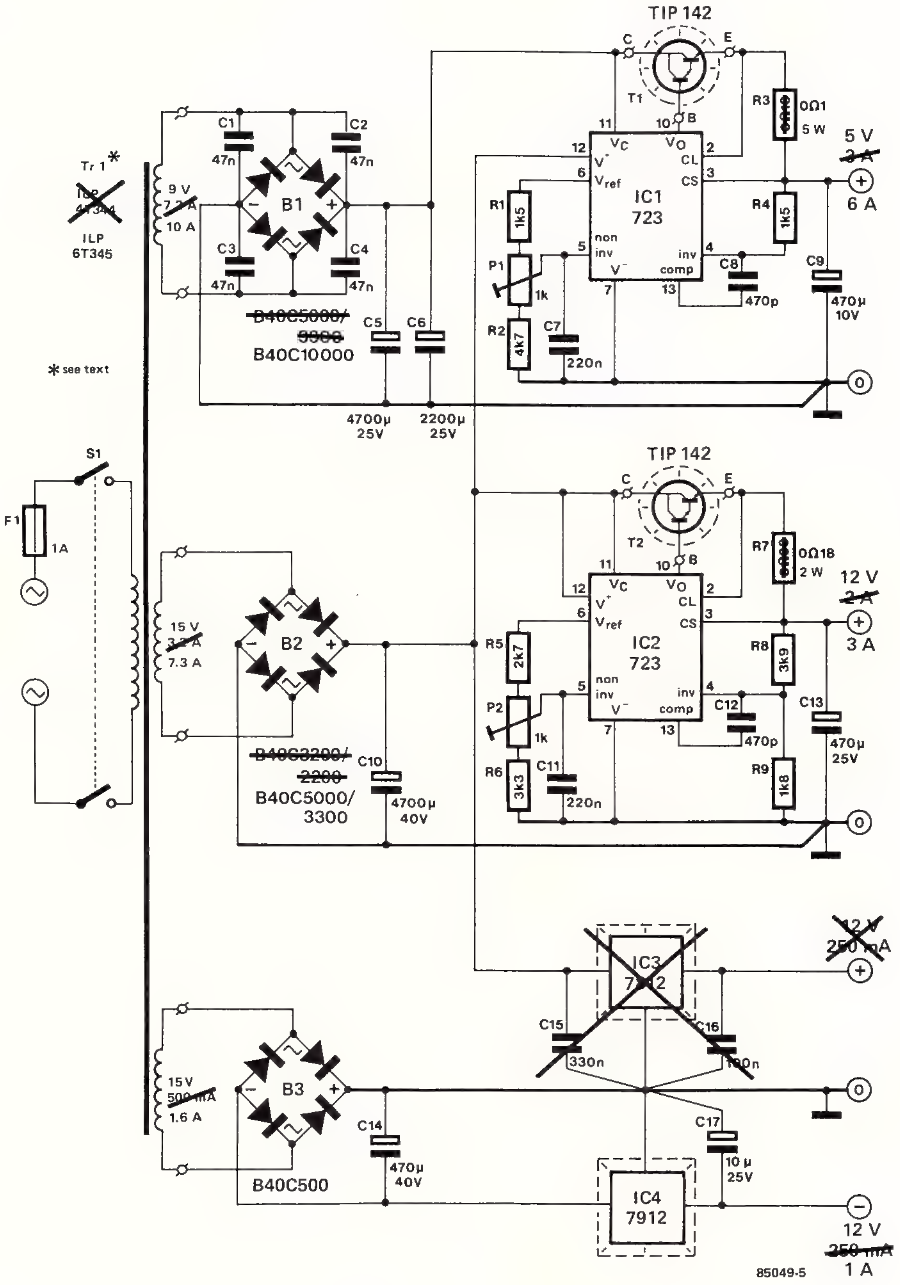


Figure 5. The power supply is an adaptation of a previously published Elektor design.

Video/floppy controller card

There are several video/floppy controller cards on the market, either in kit form or ready made. We have chosen a black and white video controller that was provided with a printer interface. Construction of this kit was simplicity itself, but its IBM compatibility raised a problem: IBM uses a line frequency of 18 432 MHz instead of the usual 15 750 MHz. This meant we could not use a normal monitor without some modification. This modification is an interface between the card and the monitor as shown in figure 8. The printer interface will be reverted to later.
There is not much to say about the floppy controller card, other than that it is used with the Shugart bus. Only when it is connected to external drives is it necessary to make a connection between the drive(s) and the D connector specially provided for this purpose on the card. Connections are shown in figure 9.

Case

Be careful when buying the case: there are at least four versions of the mother board and each has its own case. The four cases are not interchangeable.

Final test

Connect the monitor, open SW$_1$, and switch on the mains. If everything is in order, the loudspeaker, as before, should emit a high frequency tone. During the self-test procedure, the words TESTING

6a 6b

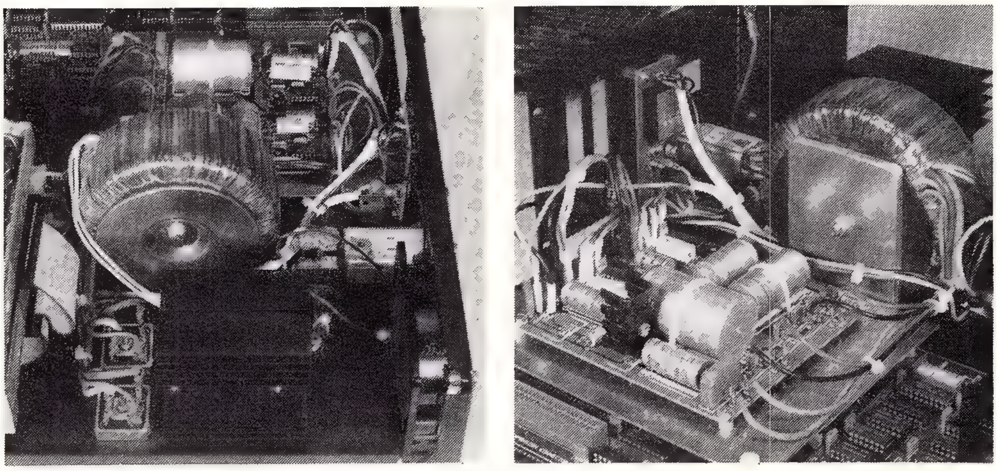


Figure 6. These photographs show how the power supply is fitted in the machine.

MEMORY appear on the screen, followed by an alternately left and right slanting line as shown in table 1a. After the tone has been emitted by the loudspeaker, the content of table 1b should appear on the screen, followed by the content of 1c.

At this stage, we ran a series of programs on our prototype: PC-DOS 2.0; PC-DOS 2.1; the entire commercial program of our accounts department (who use an IBM PC); an IBM word processor program; and an IBM flight simulator program. All these presented no problems at all.

MS-DOS programs may, however, give trouble, because these are often adapted to the slightly deviating hardware of other computers.

One problem we encountered here is that BASIC ROMs are not available from IBM, so that ROMs, or EPROMs, of other manufacture had to be used. Fortunately, these proved to be 99 per cent compatible. If you want full compatibility, it is possible to load an independent BASIC, for instance, GWBASIC, from a floppy disk.

Cards, cards...

We received virgin as well as fully constructed boards from a number of suppliers, so that we had ample opportunity to assess and compare the different versions.

The original Mega board is of high quality and can be recognized by the inscription DTC. The copies we received were of similar quality, so they should prove perfectly usable. But find out what documentation is provided with the copied boards!

The Super XT/PC board appears to be of very good quality, and is cheaper and smaller than the Mega board. We have not yet been able to test this fully, though. This board can accommodate eight EPROMs against only five on the Mega board. Moreover, just one IC is sufficient to determine which EPROMs can be selected. Figure 10 clearly shows the difference in size between the two boards. With the Mega board, it is simple to choose between 64 K DRAMs (=256 Kbyte on the mother board), and 256 K DRAMs

Table 1a.

```
Testing Memory \
Testing Memory /
Testing Memory \
       .
       .
       .
```

Table 1b.

```
MEGA-BIOS V1.0
© Display Tele-
communications
Corporation 1983
```

Table 1c.

```
Insert diskette in
      Drive A
   Press any key
```

7

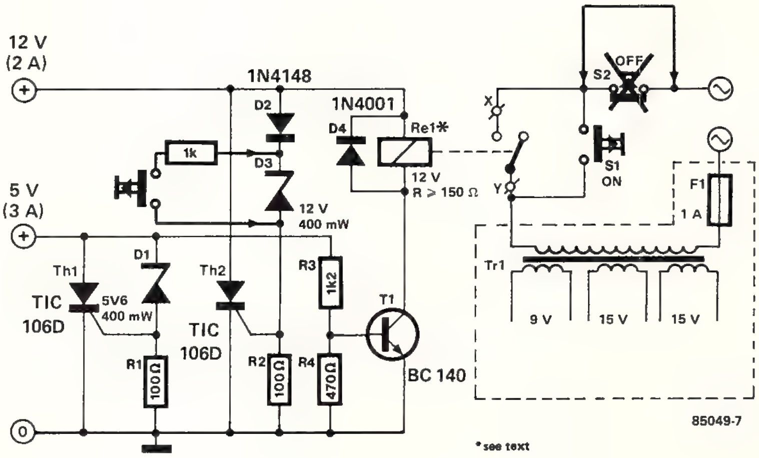


Figure 7. The power supply protection circuit is also a slightly modified previously published Elektor design.

8

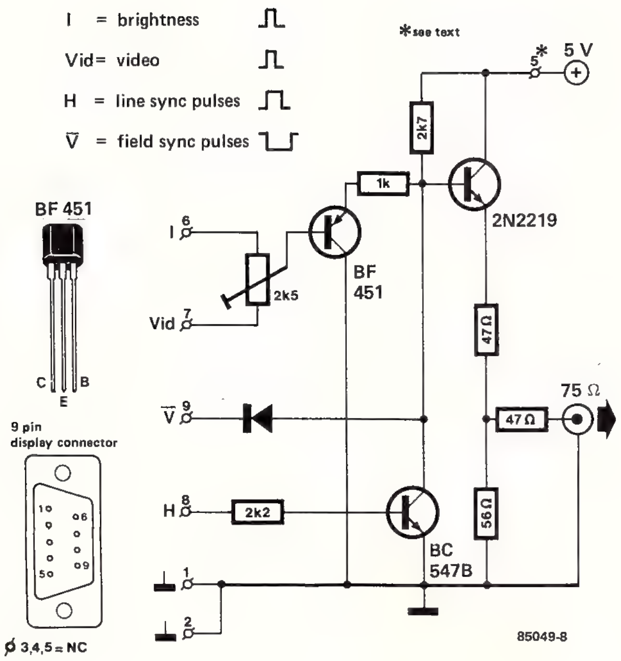


Figure 8. Interface required between the monitor and the computer.

(=1 Mbyte on the mother board). It appears that this can also be done with the Super XT/PC board, but nowhere in the documentation is it stated how.

In general terms, the documentation supplied with the Super XT/PC board is considerably less detailed than that of the Mega board. So much so, that on quite a few occasions we were glad to have the IBM PC manual to hand!

The connections to the extension cards on both types of mother board are identical to those provided in the IBM PC, so that all extension cards, including the hard disk controller of Western Digital, could be tested at once. Every one of them worked first time without any hitch. The most important of these extension cards were:

- black and white video card with printer interface;
- graphics colour video card with printer interface;
- multi-function card (memory extension — clock — calendar — cartridge adapter — and so on);
- hard disk controller.

Other cards available include digitizers, digital to analogue converters, and others. A selection of these cards (by no means all) are shown in figure 11.

9

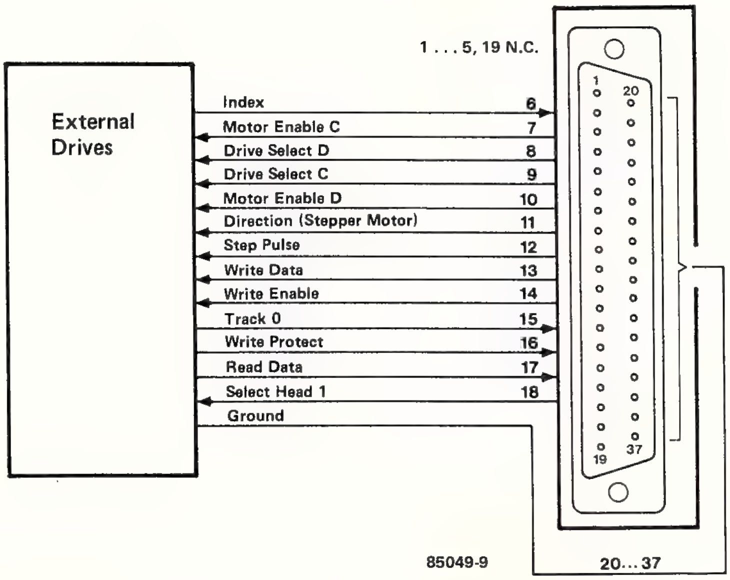


Figure 9. Connections to the external floppy drives.

10

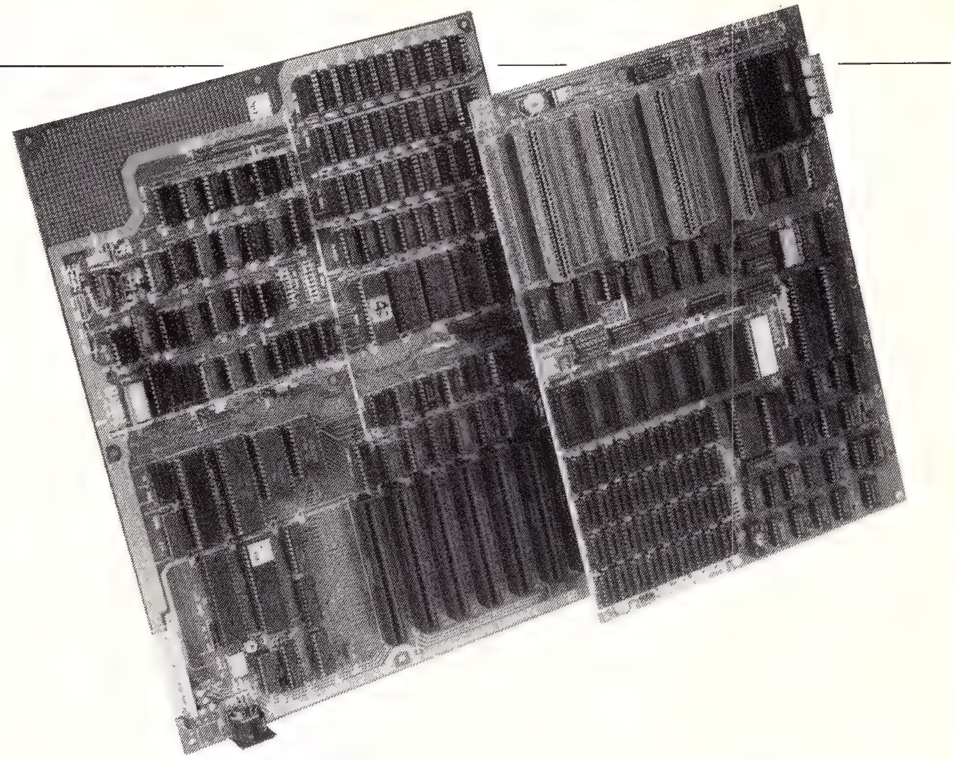


Figure 10. This photograph clearly shows the difference in size between, at the left, the Mega board and the Super XT/PC board.

Peripheral devices

To use a computer to the full, a number of peripheral units, such as a monitor, keyboard, printer, drive, and so on is required. We have already discussed the monitor.

We have tested three different keyboards which are shown in figure 12. The Staff K4 was the least expensive, and its connections are virtually the same as those of the IBM PC. The Preh Commander PC1 has rather more keys, and can also be connected without any problems. We found the arrangement of the keys better than on the K4 and the IBM PC.

The RAFI keyboard 3.94000.022 has not only the longest type number but also the greatest number of keys. In fact, there are so many that on a first glance one doubts whether they all have a purposeful function: they have! It is, however, also the most expensive of the three.

The best keyboard of the three? Our designers could not agree on the best compromise between performance, price, and convenience. It really is a matter of personal preference and taste.

Another important peripheral is a printer. If you do not yet possess one, we can only advise you, if you can possibly afford it, to get an IBM PC compatible type. This is because the IBM PC — and the present compatible micro — offers many graphics and special characters. If you use a normal printer with Centronics interface, you can, of course, print all the usual characters, so that BASIC and similar listings present no problems. The connections of the relevant D connector are shown in figure 13.

There are also specially modified printers available that have the IBM graphics and special characters in a PROM or EPROM.

11

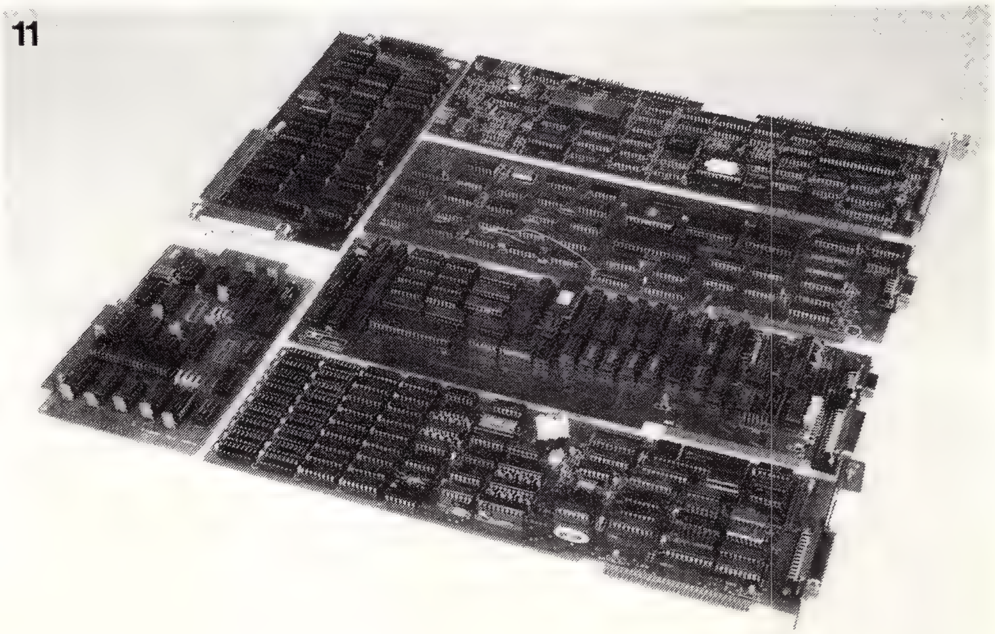


Figure 11. A selection of extension cards for use with the IBM PC and compatible micros.

12

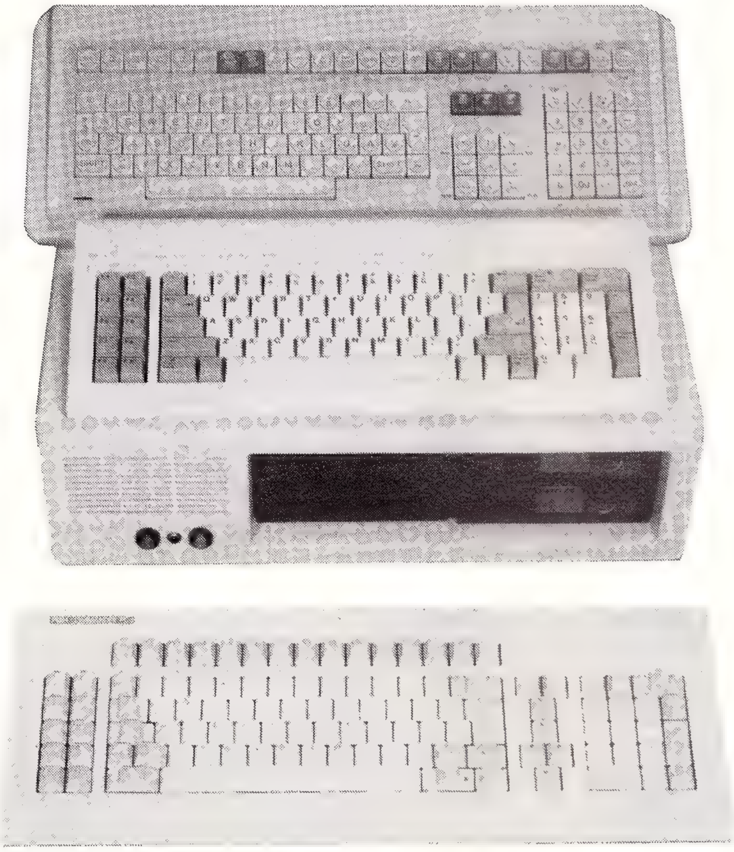


Figure 12. Our prototype together with two other keyboards we have tested.

Summary

As we stated at the beginning, this project can be tackled by anyone with a fair amount of experience in electronics construction. The parts and components are available from specialist suppliers and, other than the few difficulties stated in the text, we had no trouble in getting them. Building this compatible yourself is cheaper than buying the ready made article only if you already have a number of the required parts, such as the power supply, drives, and so on. If you start from scratch, doing it yourself works out at about the same expense as buying an IBM PC! But, of course, when you build it yourself, you will know the machine inside out, and gain a lot of valuable experience in computer technology. And that is worth a great deal, too!

13

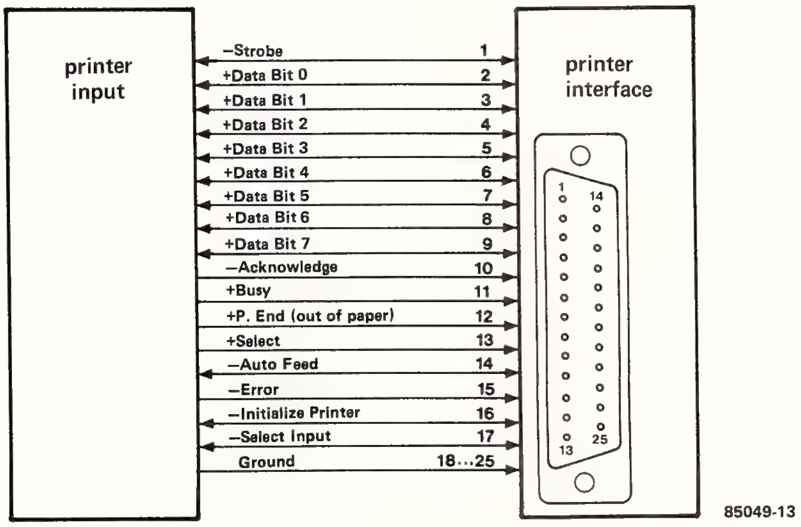
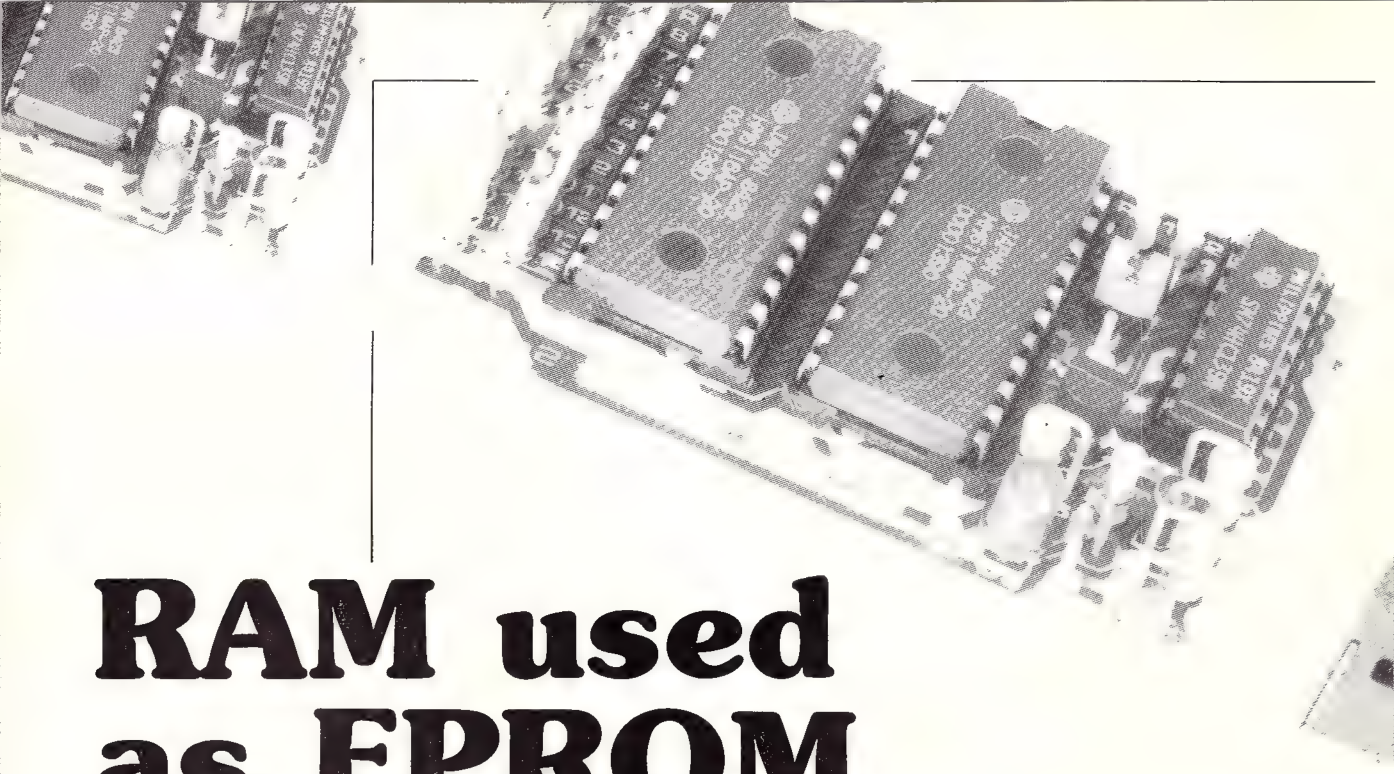


Figure 13. Connections between the printer interface and the printer.



RAM used as EPROM

As long ago as December 1981, we acquainted you with an easily programmed replacement for the 2716 EPROM: the IPROM. In September 1984, we introduced you to MOSTEK's 48Z02, which is compatible to both the 6116 RAM and the 2716 EPROM. It is now time to make you familiar with a replacement for the widely used type 2732 EPROM, consisting of two battery buffered 2 Kbyte RAMs type 6116, which can simply be inserted into the available EPROM socket. With a small additional extension, the circuit can also be used as a substitute for the less common type 2532 EPROM.

pseudo 2732

The principle of the circuit is quite simple: instead of in a 4 Kbyte type 2732 EPROM, the data is stored in two 2.2 Kbyte type 6116 RAMs. The 6116s are mounted on a small board which can be inserted into the socket intended for the 2732. When the power to the computer is switched off, batteries take over the supply of the two RAMs. As the current consumption of the 6116s is very small, the stored data can be retained in this way for over a year. The circuit behaves, therefore, as an EPROM that may be programmed like a RAM.

The circuit

The circuit diagram in figure 1 shows that a total of twenty lines are simply interconnected: the complete data bus, the address bus up to terminal A_{11} of the EPROM socket, and the $\overline{OE}$ (output enable) terminal. Each of these lines has been provided with a pull-up resistor to ensure uniform signal levels. These twenty lines do not further concern us here, as their function is the same as with an EPROM or a normal static RAM.

As regards terminals A_{11} and $\overline{CS}$ of the EPROM socket, it is essential that the correct pin of both 6116s is connected to these, and this is ensured by a 2-bit binary decoder in IC_3. Pin 3 of IC_3 is at earth potential when the power to the computer is on, and this enables the decoder. The truth table for this situation is given in table 1.

Of interest are the situations in which the $\overline{CS}$ line goes low. If address line A_{11} is also logic low, output $\overline{J0}$ becomes logic 0, and this results in IC_2 being selected. If, however, A_{11} is logic 1, output $\overline{J2}$ goes low, and IC_1 is enabled. Pull-up resistors R_{21} and R_{22} ensure uniform signal levels.

The NWDS (negative write data strobe) signal is applied to the $\overline{WE}$ (write enable) input of both 6116s via WP (write protect). This signal has quite different designations ($\overline{WR}$, $R/\overline{W}$ combined with Φ_2,...) in different computers, but is available in all of them: it is just a question of finding the line which, when logic low, enables loading the memory. If link WP is not closed, writing into the memory is not possible, and the stored data are then protected. Resistor R_{23} is the pull-up resistor for this line.

The necessary change-over to the back-up battery has been kept as simple as possible: when the supply from the computer is present, D_2 conducts, and when it is not, D_1 conducts. As the cathodes of these diodes are connected in opposition, and either the supply from the computer is higher than the battery voltage, or vice versa, there is virtually no change-over delay.

If a NiCd battery is used, this is charged via R_{24} when the computer supply is present.

When the supply from the computer is present, D_3 lights, and T_1 is on. The $\overline{G}$ pin of IC_3 is then connected to earth and the decoder in IC_3 is enabled. Diode D_3 should be a red LED: the different resistance of LEDs of another colour would shift the switch-on point of T_1.

It is clear from the above why IC_3 should be an HC or HCT type: the decoder needs power even when the supply from the computer is off. This power is, however, very small: in stand by operation, the current consumption is less than 10 μA.

It is theoretically possible that the circuit malfunctions, but only through a fault of the computer. It may happen that for some reason the supply voltage in the computer rises relatively slowly after switch on. The power-on reset is then actuated relatively long after switch on, and in the interval spurious pulses may cause erroneous writing into the RAMs. This can be prevented by connecting R_{23} to the junction of D_1 and D_2 instead of to the computer supply as shown in figure 1.

2

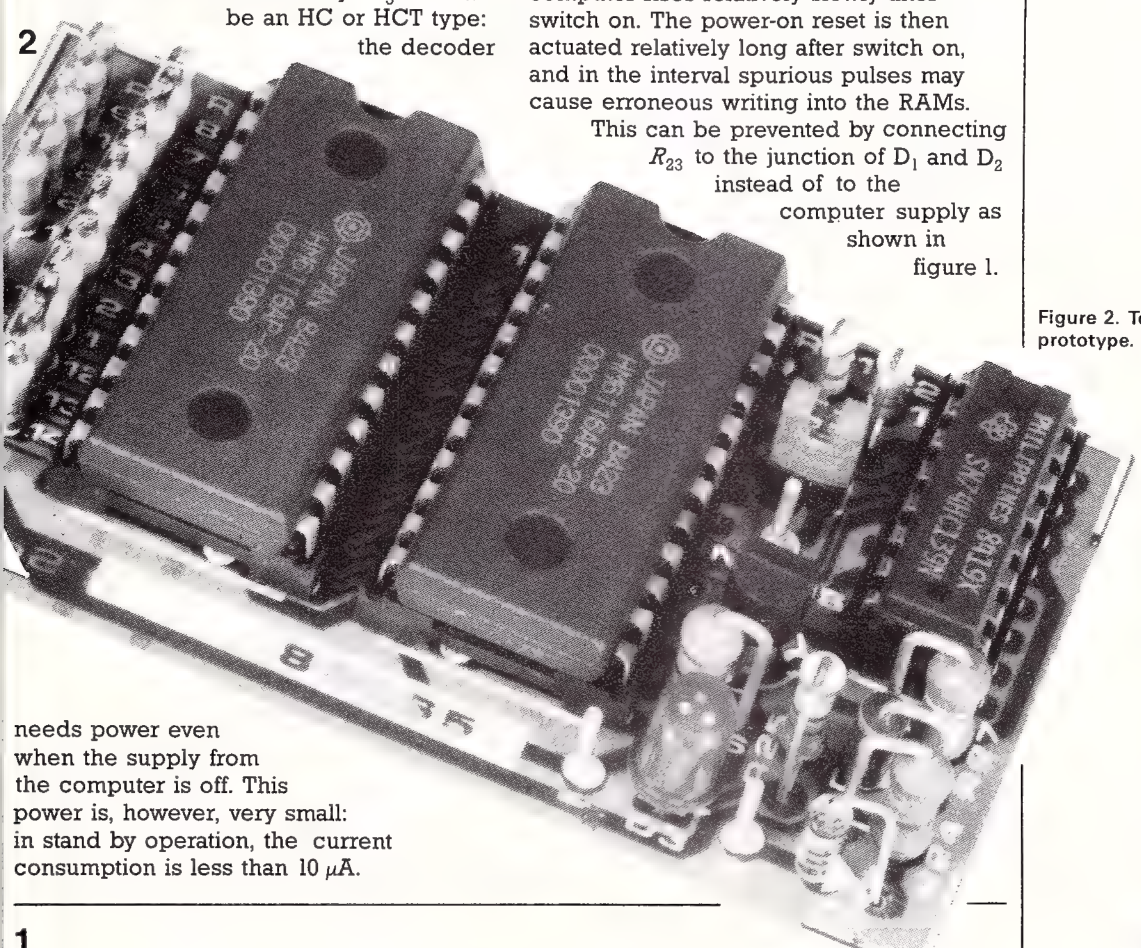


Figure 2. Top view of our prototype.

1

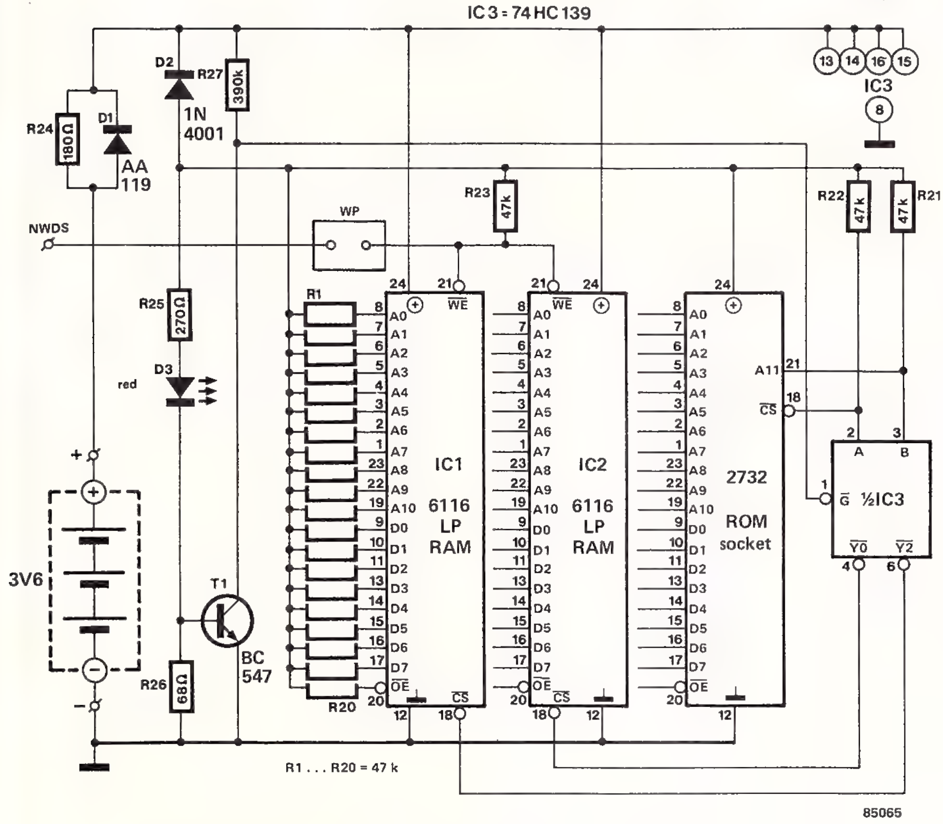


Figure 1. The circuit diagram of the pseudo 2732.

3

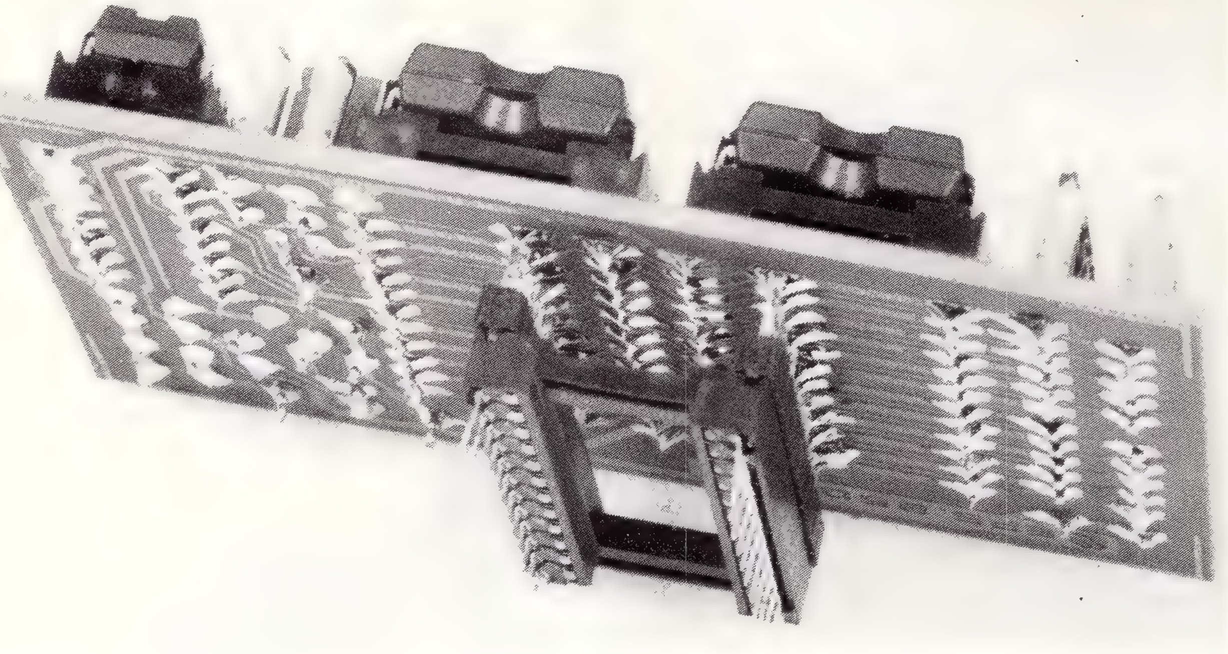


Table 1.

A_{11} = B	$\overline{CS}$ = A	$\overline{J0}$ = $\overline{CS}$ IC_2	$\overline{J1}$	$\overline{J2}$ = $\overline{CS}$ IC_1	$\overline{J3}$
0	0	0	1	1	1
0	1	1	0	1	1
1	0	1	1	0	1
1	1	1	1	1	0

Table 1. Truth table of the binary decoder in IC_3: for the purposes of this article, only $\overline{J0}$ and $\overline{J2}$ are of interest.

Figure 3. Underside view of our prototype.

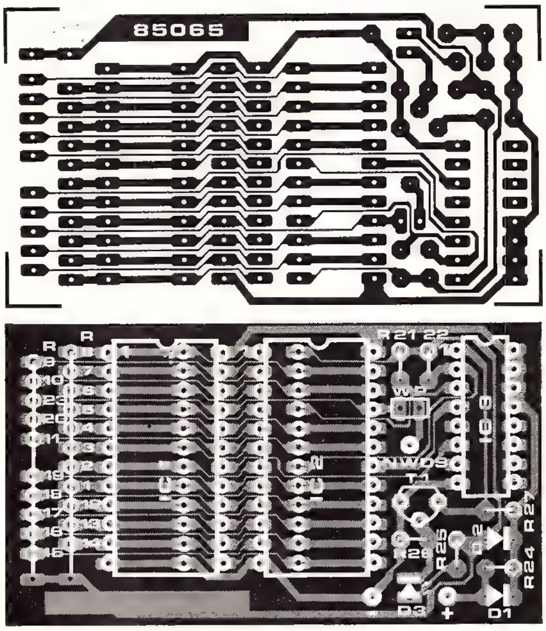
Figure 4. The printed circuit board of the pseudo 2732.

Figure 5. The interconnections required for the construction of an adapter plug for use where a 2532 needs to be replaced.

Construction

The construction of our prototype is shown in figures 2 and 3. The printed circuit board used is shown in figure 4. We have used single row pcb type terminal strips for the connections at the underside of the board.
The EPROM socket in the computer should be of good quality, because the pins of the terminal strips are slightly thicker than standard IC pins. It may, therefore, be advisable to use an adapter socket as shown in figure 3.

4



Parts list

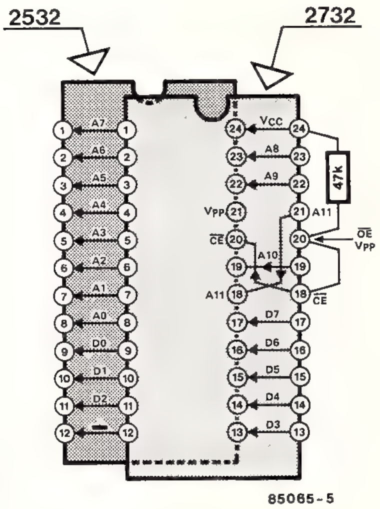
Resistors:
(all resistors are 1/8 W)

$R_1 \ldots R_{23}$ = 47 k
R_{24} = 180 Ω
R_{25} = 270 Ω
R_{26} = 60 Ω
R_{27} = 390 k

Semiconductors:
D_1 = AA119
D_2 = 1N4001
D_3 = LED, red, 5 mm
IC_1, IC_2 = 6116LP
IC_3 = 74HCT139 or 74HC139

Miscellaneous:
NiCd or dry battery, 3V6 (3 × 1.2 V)
Single row, 26 way, pcb type terminal strip
Shorting plug (for WP)
PCB 85065

5



2532 extension

To enable 2532 EPROMs also to be replaced, it is necessary to construct an adapter plug from two 24-pin IC sockets: the interconnections are shown in figure 5. The 2732 socket must be the higher one of the combination. This adapter plug can also be used to substitute a 2732 EPROM for a 2532 type in an existing circuit (but not during programming!).

A tip

It may be beneficial to reread the article *universal memory card* in the March 1983 issue of *Elektor*, which contains some fundamental and important information regarding CMOS RAMs, particularly the 6116. It also explains the necessity of pull-up resistors.

missing link

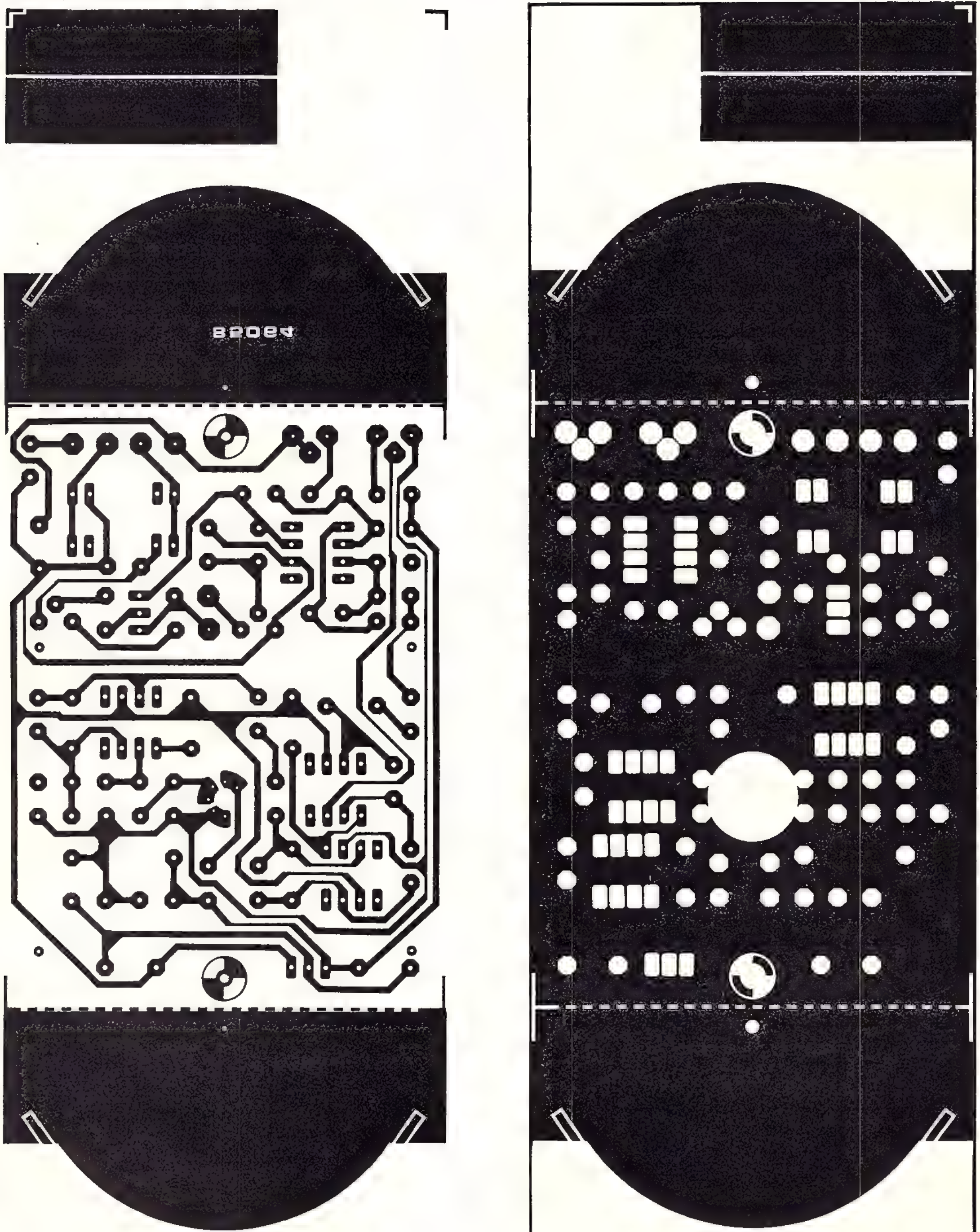
a new keyboard for Spectrum

(March 1985, page 3-48)
The circuit diagram in figure 3 oncorrectly gives the value of R_{35} as 4k7: this should be 47 k.

service

DANGER! Ultra-violet light is harmful to your eyes, so when working with a mercury vapour lamp, wear some form of *effective* eye protection.

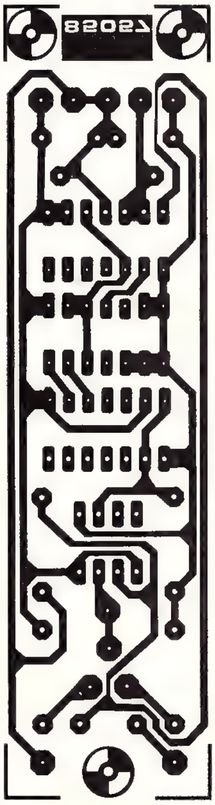
infra-red movement detector



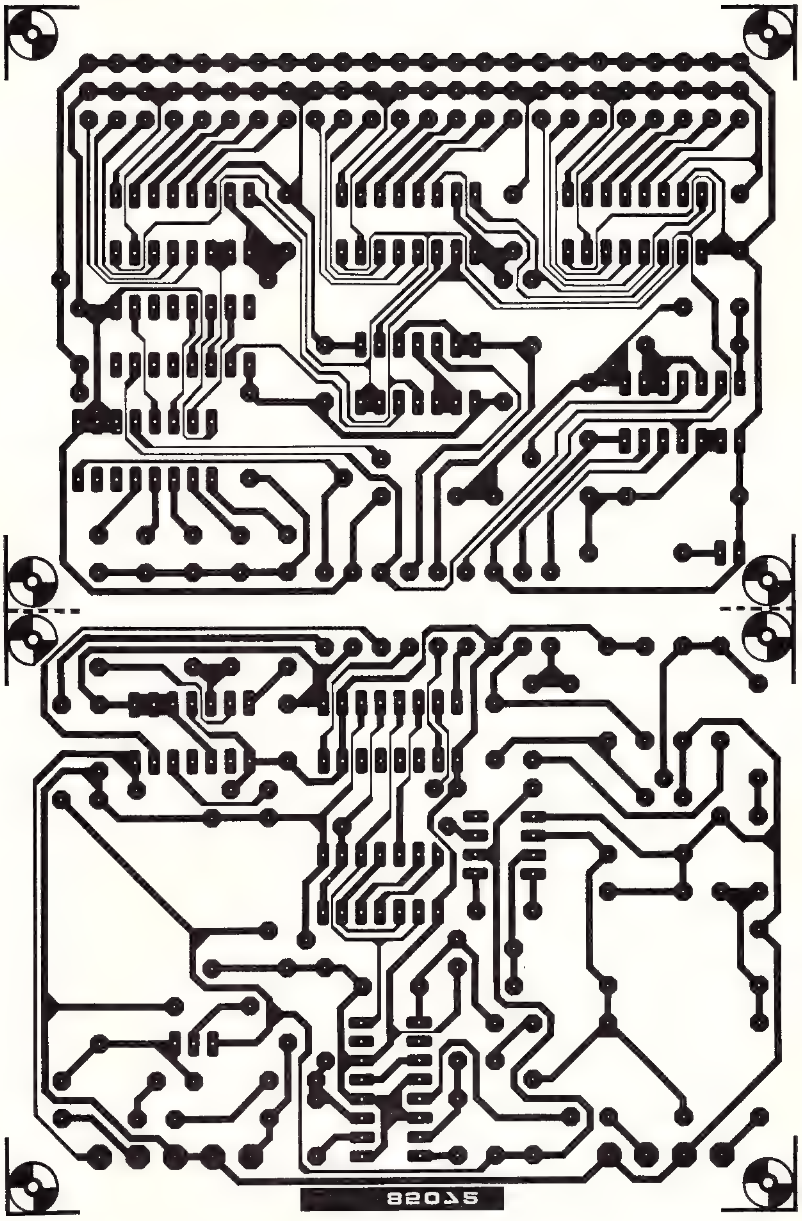
service

DANGER! Ultra-violet light is harmful to your eyes, so when working with a mercury vapour lamp, wear some form of *effective* eye protection.

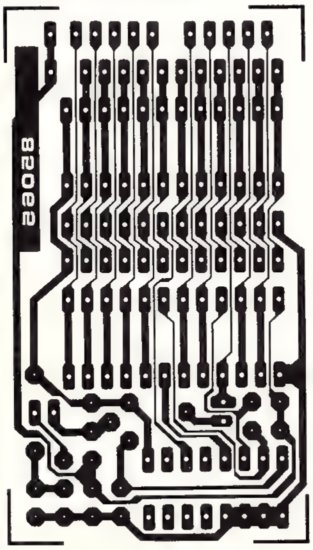
tone burst generator



auto service timer

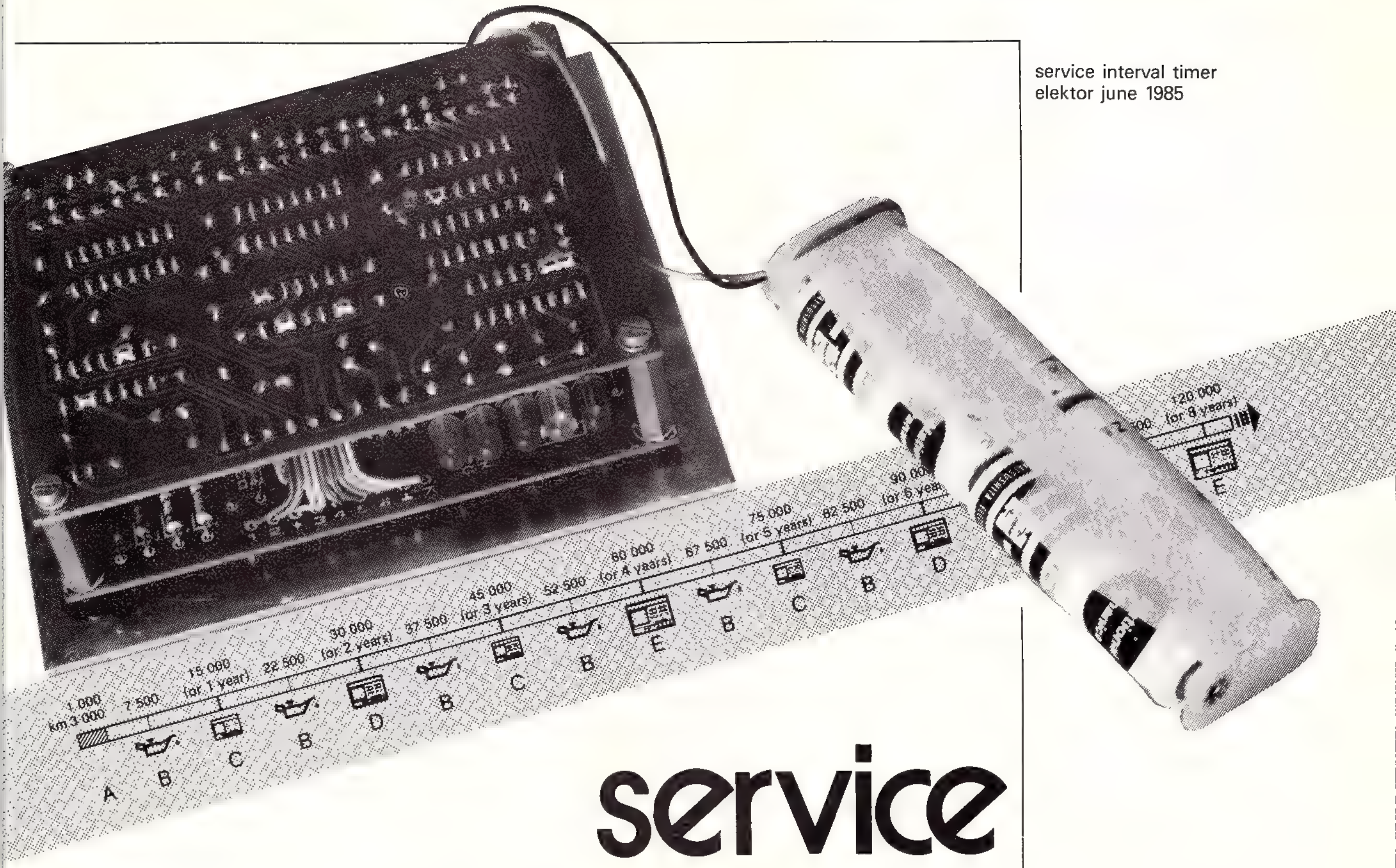


RAM used as EPROM



service

PC board pages



service interval timer

warns to have your car serviced

One hundred years ago the horseless carriage was born, and what a birth that was, for the motor car, after a timed youth, has now become an indispensable part of our modern way of life. A century of development has, of course, brought about much improvement, fortunately so, as even a short quarter-century ago there were plenty of cars needing servicing every 500 or 1000 miles. Now the service interval for many cars is 12 000 miles. Ideal though this might seem, it is not faultless. Twelve thousand miles is more than six months driving for most people and it is easy to forget whether the last service was at 16 934 or 19 364 miles. Furthermore, mileage is only one of the factors that should be taken into account in considering when a car should be serviced. The speed and temperature at which the engine is run also play an important part.

A few (expensive) cars today provide the driver with an indication of how close the vehicle is to needing a service. Our circuit is modelled on these and bases its judgement on the three factors we have already mentioned. It then provides an indication by five LEDs, three green 'nothing to worry about', one yellow 'service not yet needed', and one red 'time for a service'.

Few and far between are the cars that today require any service attention at intervals shorter than every 6000 miles and even that is usually little more than an oil change. Service intervals are still, however, stated as if the distance covered was the only important factor. This is, of course, not so. The engine requires regular attention but how often is a function of how hard it is used. Car manufacturers play it safe and specify a conservative service interval although they, more than anyone, know that neither hours of service nor distance covered is an infallible indication as to the engine's condition.

One car maker in particular, BMW, has questioned its customers extensively about how they use the car. A number of distinct types of journey were identified: short trips, starting from cold, long trips, consistently high-revolution running, and economical driving. A distinction could then be made of the most important factors affecting significant engine components. The studies revealed four factors that are of primary importance:

- the temperature at the start of a trip;
- the engine speed;
- the engine temperature; and
- the distance covered since the last service.

We will look at these in turn.

The initial temperature

This is of vital importance to an engine's health. At our latitudes the winter is not necessarily warm (like last winter, for example). The lower the ambient temperature, the longer it takes a car to reach correct operating temperature. For the sake of our circuit, we have not made a point about measuring the engine's temperature but have just divided it into two ranges: above and below 50°C.

Engine speed

In general, there is a point at which a car's fuel consumption increases noticeably. This occurs about half-way between the torque peak and maximum power. Every car is different, of course, but we have taken 4500 rev/min as an acceptable value.

Operating temperature

Every engine has a specific operating temperature at which it works best. If the actual temperature is lower than this ideal, the engine suffers.

Distance covered

This has, until now, been the only factor quoted with reference to service intervals. As we know that just distance is not enough, we add the other factors stated and arrive at the following formula for effective distance:

$D_r = [D(1+P_t+P_r)/R_a]$km

where D_r = effective distance in km; D = measured distance in km; P_t = temperature penalty; P_r = rev/min penalty; and R_a = average engine speed for the journey. We picked the brains of the automobile industry for the values in the formula. For engine speeds above 4500 rev/min P_r has a value of 0.5; below this point P_r is 0. If the engine temperature is less than 50°C P_t is 1; above 50°C P_t is 0. What all this means for our circuit we will now see.

Block diagram

The block diagram of figure 1 shows that this circuit contains three sensors: number of wheel revolutions = distance; temperature above or below 50°C; and engine speed above or below 4500 rev/min. It also has a section that makes a correction for the size of the wheels and this is connected to a divider and a display. We will look at each section in turn.

The distance sensor gives one pulse for every revolution of the car's wheels, which is translated into a certain number of pulses per kilometre (or mile). We consider this to be a better idea than an

1

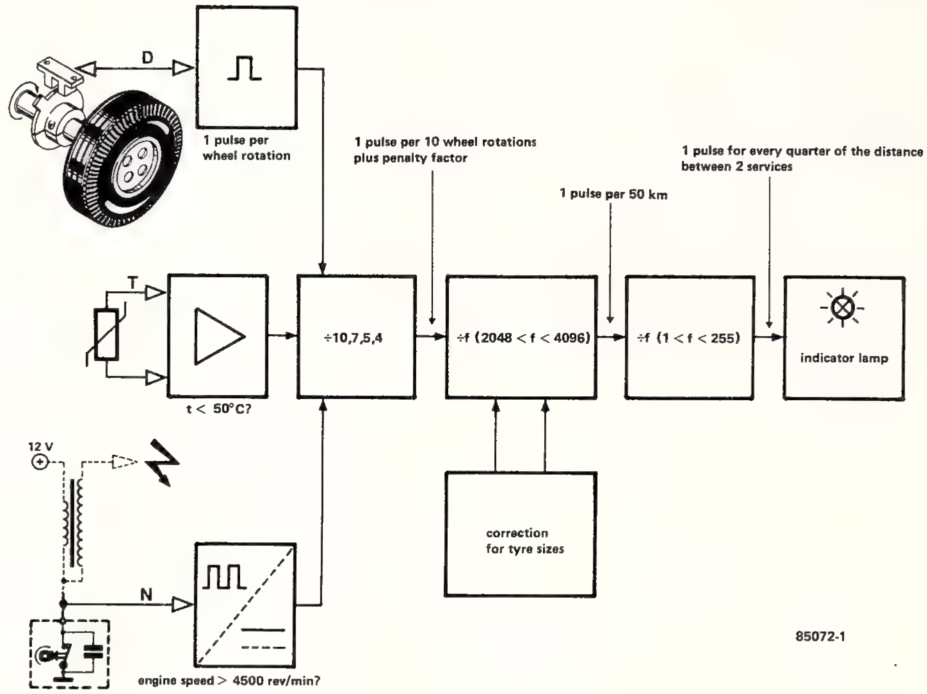

D
1 pulse per wheel rotation
1 pulse per 10 wheel rotations plus penalty factor
1 pulse for every quarter of the distance between 2 services
1 pulse per 50 km
T
t < 50°C?
÷10,7,5,4
÷f (2048 < f < 4096)
÷f (1 < f < 255)
indicator lamp
12 V
N
correction for tyre sizes
engine speed > 4500 rev/min?
85072-1

Figure 1. This block diagram shows that the service interval timer is far from complicated. It takes the information provided by three sensors and calculates the effective distance covered since the last service. The way in which the car is driven determines the penalty (from 1 to 2.5) that is included.

2

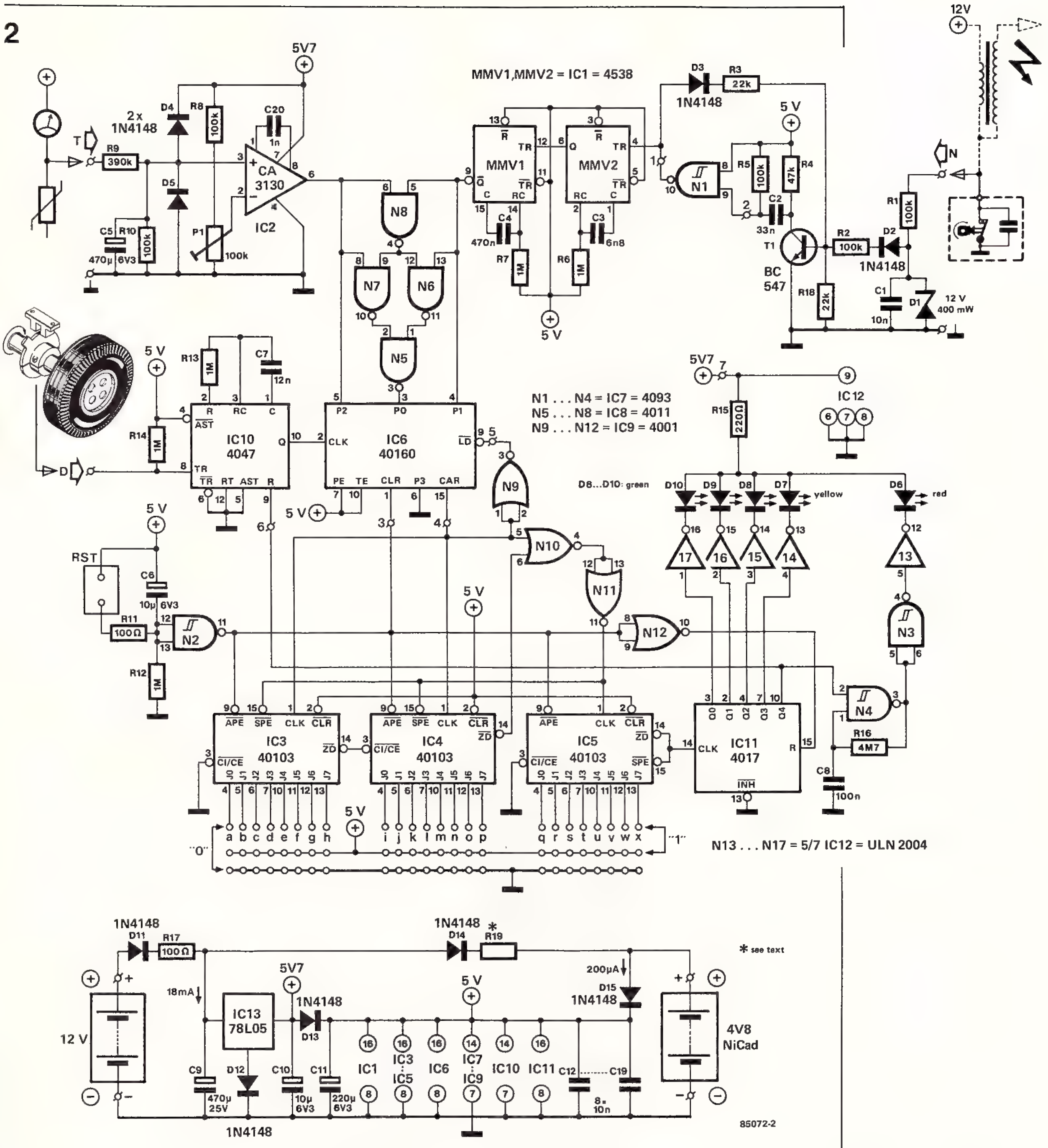


Figure 2. Although it looks a bit involved, the service interval timer circuit closely follows the block diagram. The three sensors are clearly visible and are connected via a number of programmable counters and dividers to the LED display section.

odometer giving a reading of the distance covered.

The engine temperature can be based on that of either oil or water and is one of the important operating conditions for the motor. The engine speed sensor only makes a distinction between speeds above and below 4500 rev/min. This is, of course, an arbitrary value, assuming that maximum power is developed at about 6000 rev/min. As a general rule this sensor should be set to a value of ¾ the engine speed at maximum power.

These three sensors feed a programmable divider which introduces the penalty factors and provides one pulse per wheel revolution. This signal feeds a double programmable divider (with a compensation for tyre size) so that the resulting signal gives one pulse for every corrected 50 kilometres covered. This is then fed to another programmable divider where the wanted divisor is set to control the decimal counter and the display.

The circuit

The circuit of figure 2 looks a bit daunting at first sight but it is not at all complicated. We have used an existing sensor for the engine temperature by tapping the wire feeding the water temperature gauge on the dash. The output of the 3140 opamp flips from high to low as soon as the voltage applied to pin 3 becomes higher than that at pin 2. This must occur as the temperature rises to 50°C and is set by preset P_1. Input P_2 of IC_6 is consequently taken either high or low.

The engine-speed sensor should be well known to you by now as it has appeared

2^0 = 1 (a)
2^1 = 2 (b)
2^2 = 4 (c)
2^3 = 8 (d)
2^4 = 16 (e)
2^5 = 32 (f)
2^6 = 64 (g)
2^7 = 128 (h)
2^8 = 256 (i)
2^9 = 512 (j)
2^{10} = 1024 (k)
2^{11} = 2048 (l)
2^{12} = 4096 (m)
2^{13} = 8192 (n)
2^{14} = 16384 (o)
2^{15} = 32768 (p)

Converting the factor to a binary value:
20 999 − 32 768 is negative;
J_7 de IC_5 (p) = 0,
20 999 − 16 384 = 4 615 so
J_6 de IC_5 (o) = 1,
4 615 − 8 192 is negative;
J_5 (n) = 0,
4 615 − 4 096 = 519,
J_4 (m) = 1
J_3 (l) = 0;
J_2 (k) = 0
519 − 512 = 7, J_1 (j) = 1
J_0 (i) = 0;
J_7 (IC_4 (h) = 0
J_6 (g) = 0;
J_5 (f) = 0;
J_4 (e) = 0;
J_3 (d) = 0
7 − 4 = 3, J_2 (c) = 1
3 − 2 = 1, J_1 (b) = 1
1 − 1 = 0, J_0 (a) 1.

This gives a binary number of 0101001000000111 that must be programmed at the inputs of IC4 and IC5.

in *Elektor* before (in September 1984, to be exact). It takes the pulses provided by the car's contact-breaker (c.b.) points and shapes them into a useable form. It outputs a train of regular pulses that is applied to monostable MMV$_1$ which, in combination with MMV$_2$, forms a frequency detector. The Q output of MMV$_1$ remains high for about 6.6 ms (determined by $T=R_6C_3$ which corresponds to 4500 rev/min in a 4-stroke 4-cylinder engine. The actual frequency detected is 150 Hz, given by 4500/60 × 2 (rev/min divided by 60 times 2 pulses per engine revolution). Below 4500 rev/min, MMV$_1$'s Q output is pulsed; above this value, the monostable is retriggered so the output is constantly high. The $\overline{Q}$ output of MMV$_2$ is therefore permanently high and so also is input P$_1$ of synchronous decimal counter IC$_6$ the output of which is therefore either logic 1 or 0.

The detector (a VDO pulse generator, Hall-effect device such as Siemens' HKZ101, or a reed relay and magnet arrangement) is connected to the revolution counter input. We will return to the set-up with a VDO sensor later in this article. Every time the wheel makes a complete revolution, the TR input of monostable multivibrator IC$_{10}$ receives a pulse and then outputs a pulse whose duration is given by $T=2\cdot48RC$. In our circuit this works out at about 30 ms so that bounce in the detector will have no effect. A Hall-effect sensor is, of course, bounce-free. The Q output of this MMV then provides the clock signal for IC$_6$.

Four NAND gates, N$_5$...N$_8$, together form an XOR gate which combines the different signals provided by the temperature and engine speed sensors. If both of these factors are 'unfavourable' a logic 0 is applied to input P$_0$.

The three parallel inputs of the 40160, P$_0$...P$_2$, accept a 3-bit binary word that can be 000, 011, 101, or 110. These correspond to decimal values of 0, 3, 5, and 6 and represent no penalty; a temperature penalty; rev/min penalty; and a combination of both, respectively. The 40160 counts from this input value up to 10. The relation between all the factors in question is shown in table 1, where we see the penalty in each case, the binary word input to IC$_6$, and the count needed. This latter is always the quotient of the number 10 divided by the penalty factor.

At optimal operating conditions, output pin 15 of IC$_6$ gives one pulse per ten wheel revolutions. This CARRY OUT signal is applied to the $\overline{\text{LD}}$ terminal via inverter N$_9$ so the IC starts counting again from the input value. Two programmable synchronous down-counters, IC$_3$ and IC$_4$, form a 16-bit programmable divider, in which every rising edge of the clock signal decrements the count starting from the value applied to inputs $J_0...J_7$. When the count reaches zero the $\overline{\text{CO}}/\overline{\text{ZD}}$ output becomes active (logic 0). The values that should be fed to the J inputs are shown in table 2 and the circuit is thus tuned to the size of the wheel at which the sensor is. This is done by links a...k. As for the remaining links, l is linked to +5 V and m...p to earth. This gives us a range of divisors between 2048 and 4096, but we are only interested in those between 2169 and 3236. The circumference of the wheel is taken to be the theoretical value; perfectionists may consider measuring the actual circumference but that is not really necessary.

Table 1. Penalty factors, corresponding binary word input to IC$_6$ and decimal value, and the count needed.

Table 1.

temperature (°C)	engine speed (rev/min)		P2	P1	P0	decimal value	count needed
	<4500	>4500					
> 50	1.0		0	0	0	0	10
		1.5	0	1	1	3	7
< 50	2.0		1	0	1	5	5
		2.5	1	1	0	6	4

As we have already hinted, the VDO pulse generator is a special case as it is already present on some cars' odometers (distance meters). The magnetic sensor generates six pulses for every rotation made by the speedometer cable. Where this sensor is fitted (on many Volvos, Mercedes', Opels, VWs etc.) a number between 542 and 975 is inscribed on the case.

If the sensor is numbered 700, for instance, the cable makes 700 rotations per kilometre and the sensor outputs 700 × 6 = 4200 pulses in this period. For our circuit we want to reduce this to a single pulse per fifty kilometres so we multiply this number by 50 and then divide it by 10. This gives us the desired divisor of 21 000, from which we subtract 1 and convert the result (20 999) to the binary number indicating the straps must be set. This procedure is clarified by the example in the margin here.

What we achieve by all this is that the $\overline{\text{SPE}}$ output provides one pulse for a 'real' distance of 50 km. Another programmable synchronous down-counter, IC$_5$, is used to define the number of 50 km intervals counted before sending one pulse to decimal up/down counter IC$_{11}$. Keeping things metric, we have assumed that the service interval is 10 000 km so the distance between the lighting of successive LEDs is 2500 km. The divisor of IC$_5$ is then 50. The actual programmed divisor is 49 as we must always subtract 1 from the desired value. The resulting binary value of 110001 is fed to inputs $J_0...J_7$ of IC$_5$. Straps v, u, and q are tied to +5 V and r, s, t, w, and x to earth.

Each pulse provided by the $\overline{\text{ZD}}$ output increments IC$_{11}$, making the next output active and lighting the next LED via inverters N$_{13}$...N$_{17}$. The final (red) LED is made to flash by the multivibrator consisting of NAND gates N$_3$ and N$_4$ to draw the driver's attention to the fact that a service is due.

Two sections of the circuit have not yet been described, the first of which is called RST (reset). This consists of a pair of contacts connected to N_2. When the car has been serviced, these two contacts are closed briefly and the whole circuit is then reset.

At the lower right-hand corner of the circuit we see a NiCd 4.8 V battery that is kept charged via R_{19}. The charging current is taken as 1/25 of the nominal current which is 20 mA in this case. The car battery voltage and Ohm's law ($R = U/I$) give the resistance. For a 12 V car battery R_{19} will be about 600 Ω.

Construction

The printed circuit board shown in figure 3 reduces construction to a matter of correct and careful soldering. First, however, the board must be cut into two. As usual, make sure that semiconductors and electrolytic capacitors are fitted with correct polarity and we recommend that good quality sockets be used for the CMOS ICs. Check that all the links are fitted as there are a full dozen, not including those needed for programming. Nine short lengths of flexible cable are needed to interconnect the two boards. When you are sure the circuit is working correctly, the two boards can be fixed together like a sandwich, with the components in the middle. The LEDs must be mounted such that they all face forward. For the sake of aesthetics, rectangular LEDs can be used but if the red LED is not striking enough, a round version will give a better indication.

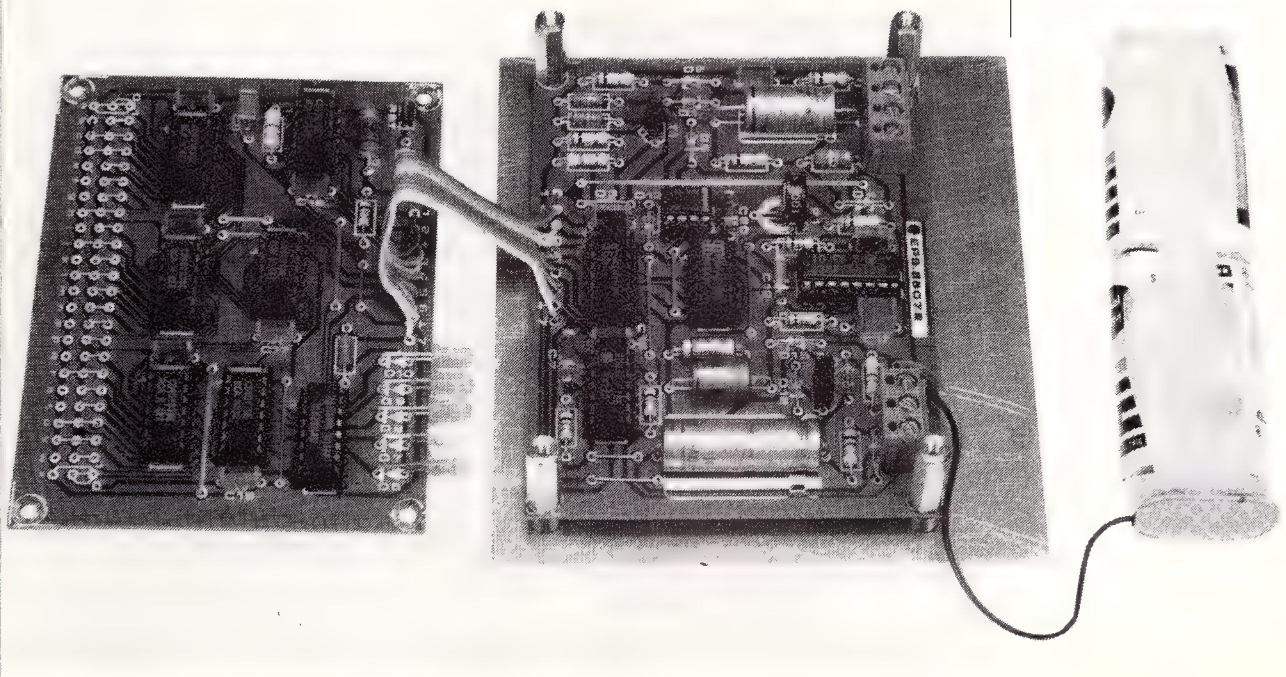
Table 2.

type of tyre	circumference	divisor for 1 pulse per 50 km	links k j i h g f e d c b a
125 - 15	184.1	2716	01010011101
135 - 12	165.3	3025	01111010010
135 - 13	173.3	2885	01101000110
145 - 10	154.5	3236	10010100101
145 - 12	170.5	2933	01101110110
145 - 13	178.4	2803	01011110100
145 - 14	186.4	2682	01001111011
145 - 15	194.4	2572	01000001101
145 / 70 - 12	159.5	3135	10001000000
145 / 70 - 13	167.5	2985	01110101010
155 - 12	175.6	2847	01100100000
155 - 13	183.6	2723	01010100100
155 - 14	191.6	2610	01000110011
155 - 15	199.6	2505	00111001010
155 / 70 - 12	163.9	3051	01111101100
155 / 70 - 13	171.9	2909	01101011110
165 - 13	188.8	2648	01001011001
165 - 14	196.7	2542	00111101111
165 - 15	204.7	2443	00110001100
165 / 70 - 13	176.3	2836	01100010101
165 / 70 - 14	184.3	2713	01010011010
165 / 65 - 13	171.1	2922	01101101011
165 / 65 - 14	179.1	2792	01011101001
175 - 13	193.9	2579	01000010100
175 - 14	201.9	2476	00110101101
175 / 70 - 13	180.7	2767	01011010000
175 / 70 - 14	188.7	2650	01001011011
175 / 70 - 15	196.7	2542	00111101111
175 / 65 - 14	183.2	2729	01010101010
185 - 14	207	2415	00101110000
185 / 70 - 13	185.1	2701	01010001110
185 / 70 - 14	193.1	2589	01000011110
185 / 70 - 15	201.1	2486	00110110111
185 / 65 - 14	187.3	2670	01001101111
185 / 60 - 14	181.5	2755	01011000100
190 / 65 - 390	200.1	2499	00111000100
190 / 55 - 340	172.5	2899	01101010100
195 - 14	212.2	2356	00100110101
195 / 75 - 14	203.6	2456	00110011001
195 / 75 - 15	211.6	2363	00100111100
195 / 70 - 14	197.5	2532	00111100101
195 / 70 - 15	205.5	2433	00110000010
195 / 60 - 14	185.2	2700	01010001101
195 / 60 - 15	193.2	2588	01000011101
205 / 75 - 15	216.3	2312	00100001001
205 / 70 - 15	209.9	2382	00101001111
205 / 60 - 13	181	2762	01011001011
205 / 60 - 14	189	2646	01001010111
205 / 60 - 15	197	2538	00111101011
205 / 55 - 16	198.5	2519	00111011000
215 - 15	230.5	2169	00001111010
215 / 75 - 15	221	2262	00011010111
215 / 70 - 15	214.3	2333	00100011110
215 / 60 - 15	200.8	2490	00110111011
220 / 55 - 365	190.7	2622	01000111111
225 / 75 - 14	217.7	2297	00011111010
225 / 75 - 15	225.7	2215	00010101000
225 / 50 - 16	198.4	2520	00111011001
230 / 70 - 15	220.9	2263	00011011000
235 / 75 - 15	230.4	2170	00001111011
235 / 70 - 15	223.1	2241	00011000010
235 / 60 - 15	208.3	2400	00101100001
235 / 55 - 15	200.9	2489	00110111010
255 / 50 - 16	207.8	2406	00101100111

Connections

The temperature detector

The vast majority of modern cars have a water temperature gauge and the simplest solution for our circuit is to tap the wire leading from sensor to meter and feed it to the circuit at point T. Then preset P_1 is adjusted (with the car at operating temperature) so that the output of IC_2 is low. A separate temperature sensor, used purely for the service interval timer, could be fitted. If this is necessary, it is important



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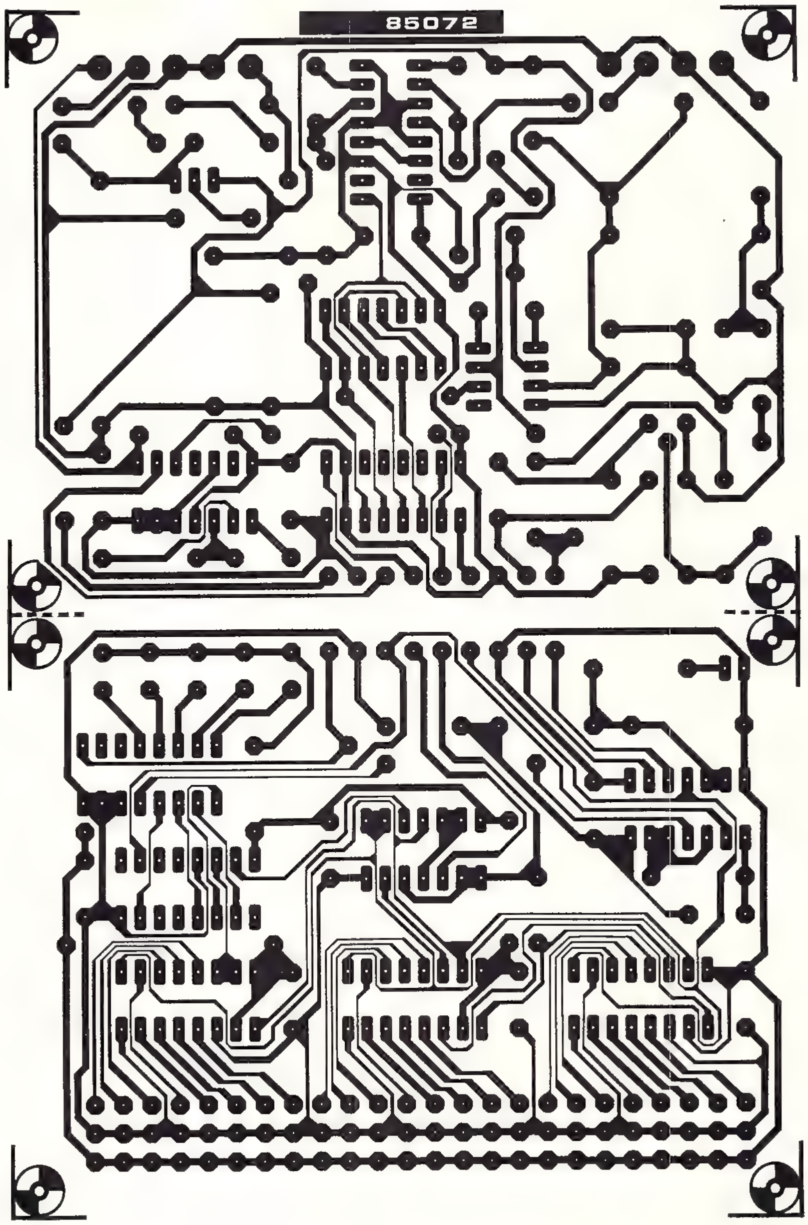


Figure 3. The printed circuit board consists of two parts that must be separated before assembly. They are then fixed together with spacers to form a sandwich.

that the sensor gives an output voltage directly proportional to the temperature, certainly in the range that is of interest to us. Such a sensor might also have to be earthed separately instead of using the single central earth that is sufficient for our circuit.

The distance sensor

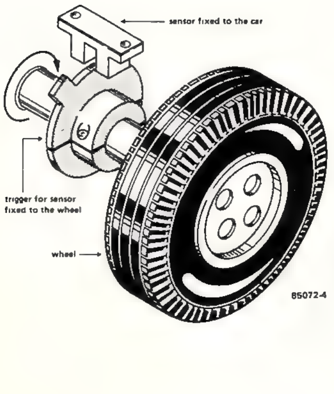
We have already talked about the special situation presented by the VDO pulse generator. This, of course, requires no mounting as it is a standard fitting in some cars. All that is needed is to link its output to terminal D of the PCB. Failing this, either a Hall-effect sensor or a reed relay plus magnet can be mounted to give one pulse per wheel rotation. The reed relay/magnet solution requires care to avoid having the result corrupted by other magnetic effects in the car. Magnetism holds no fears for the Hall-effect sensor but, as figure 4 shows, the mounting position of this sensor is rather exposed.

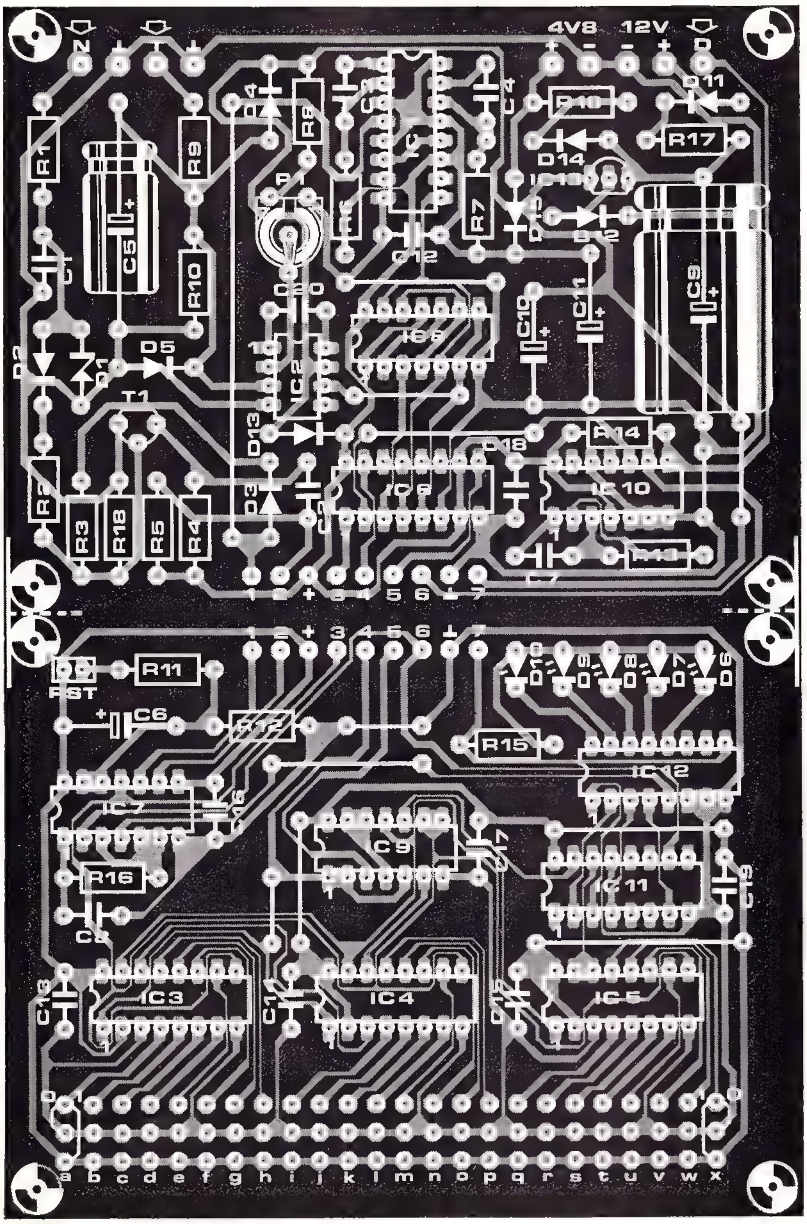
The engine speed sensor

The engine speed measurement is based on the pulses provided by the c.b. points. All you need to do therefore is to connect terminal D to the line from the coil to the c.b. points.

Programming the dividers

The fitting of links a. . .x depends on the programming factors chosen. Start by inserting a. . .k to suit the size of the car's wheels. For a normal 13 inch wheel, for example (165/13, 155/13, etc.) the links must form the binary value 01001 0101 1001. It is clear from the printed circuit board itself how to program a logic 0 or a 1. Next you have to program the distance. During the description of the circuit we have taken a distance factor of one pulse per 50 km. This was chosen for simplicity's sake (and not through some zeal to banish the good old mile), but if a different value is chosen the programming is different. Actually it is far better to accept


sensor fixed to the car
trigger for sensor fixed to the wheel
wheel
85072-4



this one pulse per 50 km and add the correction you want in the next stage. In the text we have assumed a service interval of 10 000 km, corresponding to one pulse per 2500 km for the stage in question. Your car owner's manual probably states the service interval both in miles and kilometres but should this not be so or if the interval is not 10 000 km, IC_5 must be programmed accordingly. A service interval of 15 000 km gives a divisor of 15000/4 × 50 = 75 resulting in a binary value of 1001010. The circuit can cater for service intervals up to 51 000 km and if you dare go that far without visiting a garage, don't expect any sympathy from us if you have problems.

Fitting the circuit

The circuit should be mounted so that the driver sees the LEDs when they light and then the various connections must be made. It may also be fitted under the car bonnet where it will be seen when checking the oil or water. The circuit is reset by bridging the RST contacts and the first LED should then light. All that then remains is to check that the other LEDs light at the right times (about every 2500 km in our example). In most cases, this will be 5 to 10 per cent less than the theoretical distance (between 2250 and 2375 for a theoretical value of 2500). Assuming again that we expect the LEDs to light at 2500 km intervals, the red LED can be expected at 9000...9500 km.
This circuit is no intended to supplant all other forms of car maintenance. It remains just as important to check the oil and water regularly but the service interval timer will give you an idea of how mechanically sympathetic you are. Then you can plan your servicing more sensibly, and that is certainly laudable in these days of ever-increasing garage charges. ◼

Literature:
Automonitor: Elektor April 1985

Parts list

Resistors:
R_1,R_2,R_5,R_8,R_{10} = 100 k
R_3,R_{18} = 22 k
R_4 = 47 k
R_6,R_7,R_{12}...R_{14} = 1 M
R_9 = 390 k
R_{11},R_{17} = 100Ω
R_{15} = 220Ω
R_{16} = 4M7
R_{19} = *
P_1 = 100 k preset
* = see text

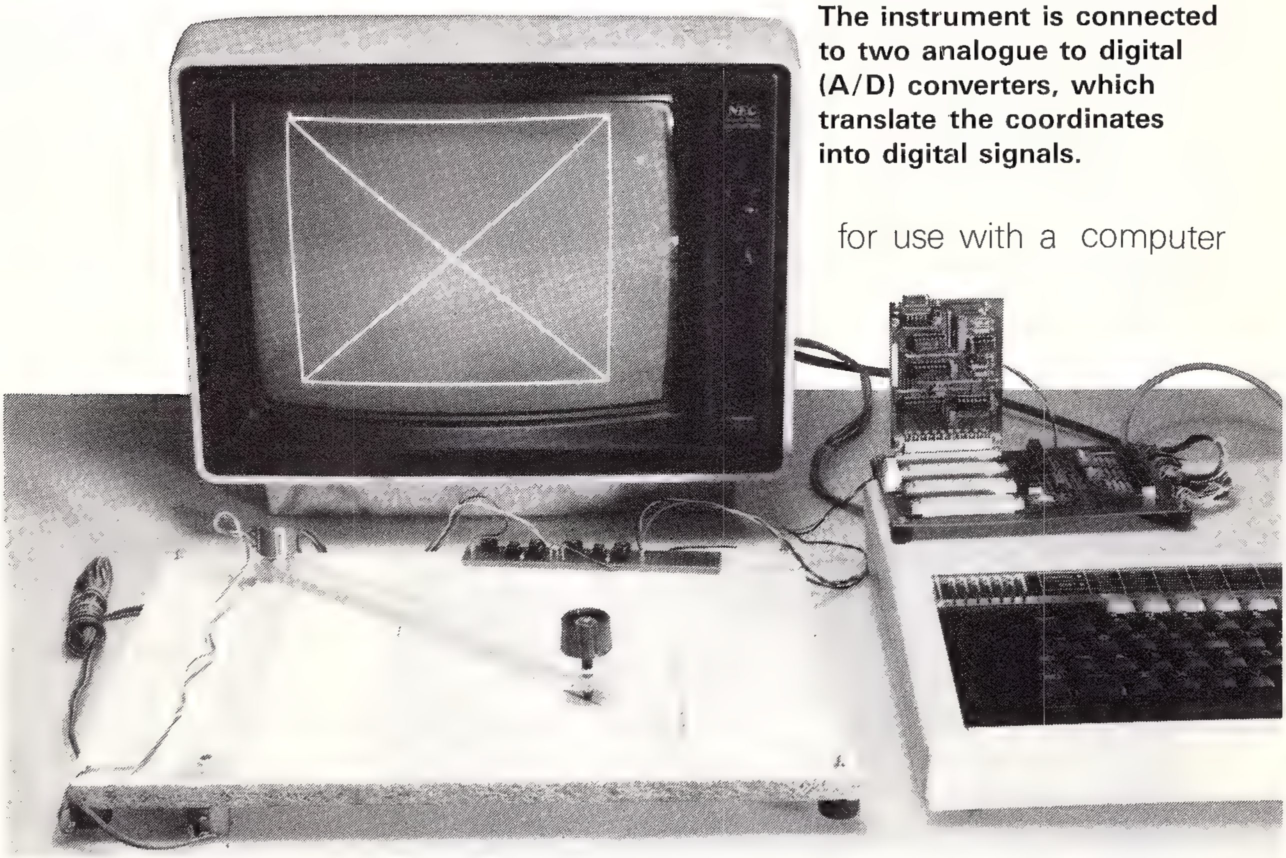
Capacitors:
C_1,C_{12}...C_{19} = 10 n
C_2 = 33 n
C_3 = 6n8
C_4 = 470 n
C_5 = 470 μ/6V3
C_6,C_{10} = 10 μ/6V3
C_7 = 12 n
C_8 = 100 n
C_9 = 470 μ/25 V
C_{11} = 220 μ/6V3
C_{20} = 1 n

Semiconductors:
D_1 = 12 V/400 mW zener
D_2...D_5,
D_{11}...D_{15} = 1N4148
D_6 = LED, red
D_7 = LED, yellow
D_8...D_{10} = LED, green
T_1 = BC547
IC_1 = 4538
IC_2 = CA3130
IC_3...IC_5 = 40103
IC_6 = 40160
IC_7 = 4093
IC_8 = 4011
IC_9 = 4001
IC_{10} = 4047
IC_{11} = 4017
IC_{12} = ULN2004
IC_{13} = 78L05

Miscellaneous:
1 off 4.8 V NiCd battery
(4.5 V might be sufficient)

A pantograph is an instrument with jointed rods for copying plans, drawings, etc., on any scale; the electronic version described in this article does so in graphics form on the monitor of a computer. It may also be used for drawing or writing direct onto the screen. The instrument is connected to two analogue to digital (A/D) converters, which translate the coordinates into digital signals.

for use with a computer



electronic pantograph

At the point of origin in figure 1 is a potentiometer to the spindle of which one of the rods of the pantograph, of length R, is connected. When that rod is moved, the potentiometer setting is changed. If the potentiometer is positioned such that it is at zero when the rod coincides with the negative x-axis, its angle of rotation in figure 1 is α. At the end of the rod is a second potentiometer, to whose spindle a second rod is connected, also of length R. The connection between the second potentiometer and second rod is such that the potentiometer is at zero when the two rods coincide. The angle of rotation of the second rod, and consequently the second potentiometer, with respect to the first rod is β. The coordinates of the end of the second rod, x_1,y_1, are calculated from the length, R, of the two rods, and the angles α and β.

Since the potentiometers are potential dividers, the voltage at their wipers is directly proportional to their angle of rotation. These voltages are translated by analogue to digital converters into binary digits (=bits) from which the computer can calculate the x and y coordinates.

As the total reach of the pantograph is $2R$, the drawing area should be a square with sides $1.414R$ or a rectangle with a long diagonal of $2R$. Note that the pantograph is intended for use in the first and fourth quadrants of a polar diagram; our prototype is for the first quadrant only.

The electronics

The electronics required for the transfer of the analogue output of the potentiometers to the A/D converters is minimal, as shown in figure 2 for one potentiometer. The signal from pantograph potentiometer P_1 is applied to the non-inverting input of operational amplifier IC_1. The inverting input of IC_1 is connected to P_2 which serves to set the point of origin (i.e., compensates for the offset of the opamp).

1

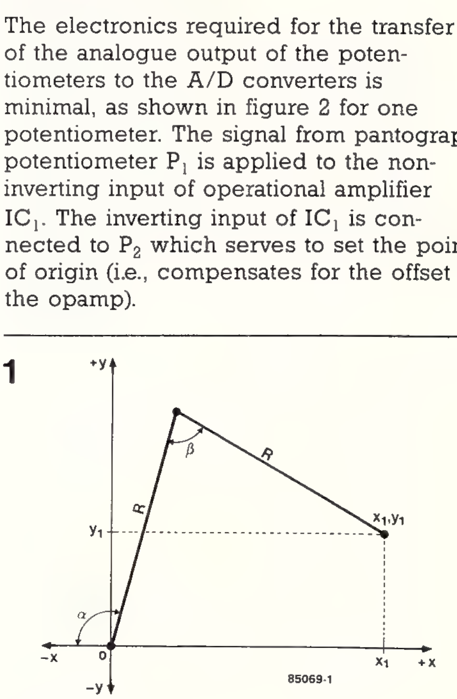


Figure 1. This diagram illustrates the operation of the pantograph. Coordinates x_1, y_1 are calculated from R and angles α and β according to the following formulas.
$x_1 = R[\cos(\beta-\alpha)-\cos\alpha]$
$y_1 = R[\sin(\beta-\alpha)+\sin\alpha]$

2

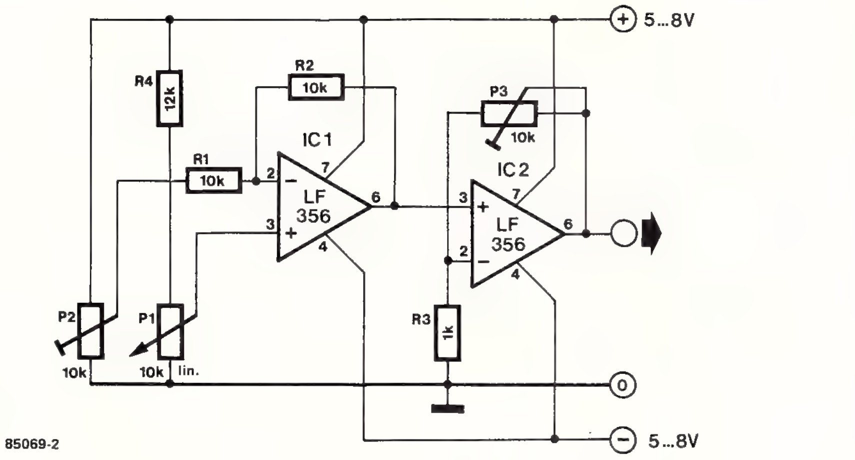
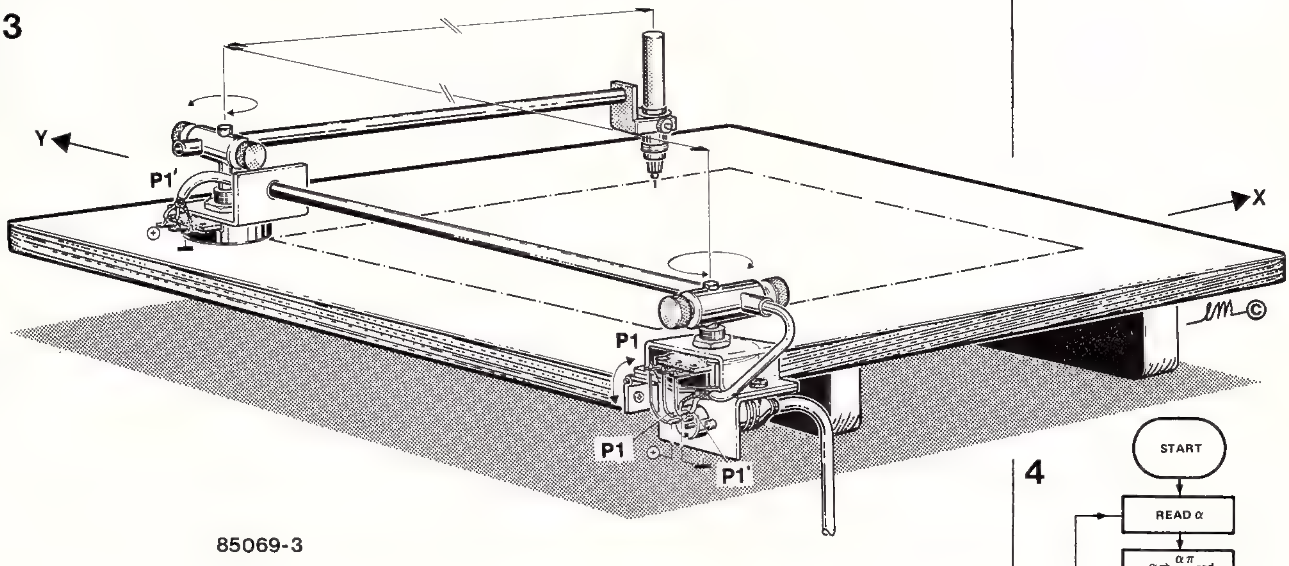


Figure 2. Two ICs provide the coupling between each pantograph potentiometer and an A/D converter. Potentiometer P_2 provides offset compensation, while P_3 sets the amplification of IC_3.

Figure 3. Possible construction of the electronic pantograph. The drawing area here only covers the first quadrant of a polar diagram.

figure 4. Flow chart giving guidelines on how the associated program must be designed.

3



A second operational amplifier, IC_2, provides direct voltage amplification as required; the gain may be set between 0 dB and 21 dB with P_3. The output of IC_2 is fed to the A/D converter.

Each pantograph requires two circuits as shown in figure 2: one for each of its potentiometers.

The power supply for the circuits must be well regulated: its current consumption amounts to only a few milliamperes.

The A/D converters may be constructed as described in *digitizer* in the May 1985 issue of *Elektor*. If you use this, you need only one because it has switched inputs.

The mechanics

The mechanical part of the pantograph is fairly simple and will not be described in detail, because the construction depends largely on the materials used. It is important to use good quality potentiometers; we found the best linear behaviour in ten-turn wire-wound types. The rod connected to the potentiometer in the point of origin must be mounted so that it can move freely between the negative and positive *y* axes. The second rod must be fixed to the relevant potentiometer spindle so that it can move freely between 0° and 180° with respect to the other rod.

Calibration

When the pantograph is ready and connected to the computer and monitor via the A/D converter(s) and universal I/O bus, let the rods coincide over the negative *x* axis (so that both α and β in figure 1 are 0°). The computer should contain a program for the reading of the A/D converters: this is described in the *digitizer* article referred to. Then adjust the output of IC_1 (for both pantograph potentiometers) to exactly 0 V with P_2. Finally, position the rods at maximum angle of rotation (i.e., along the positive *x* axis), and adjust the output voltage of IC_2 (for both pantograph potentiometers) with P_3 until the A/D converters have an output of 255.

Finally

The program for processing the information from the pantograph depends entirely on the applications. In most cases, it will be required to display on the monitor screen the pattern being traced with the pantograph. Provided you have some experience in BASIC programming and computer graphics, such a program should not be too difficult to design. ◼

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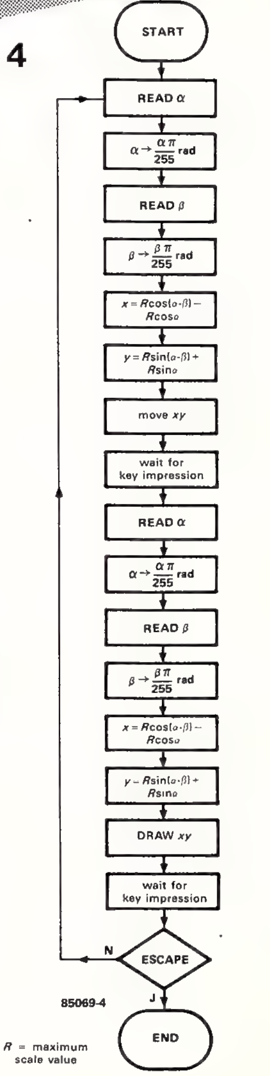
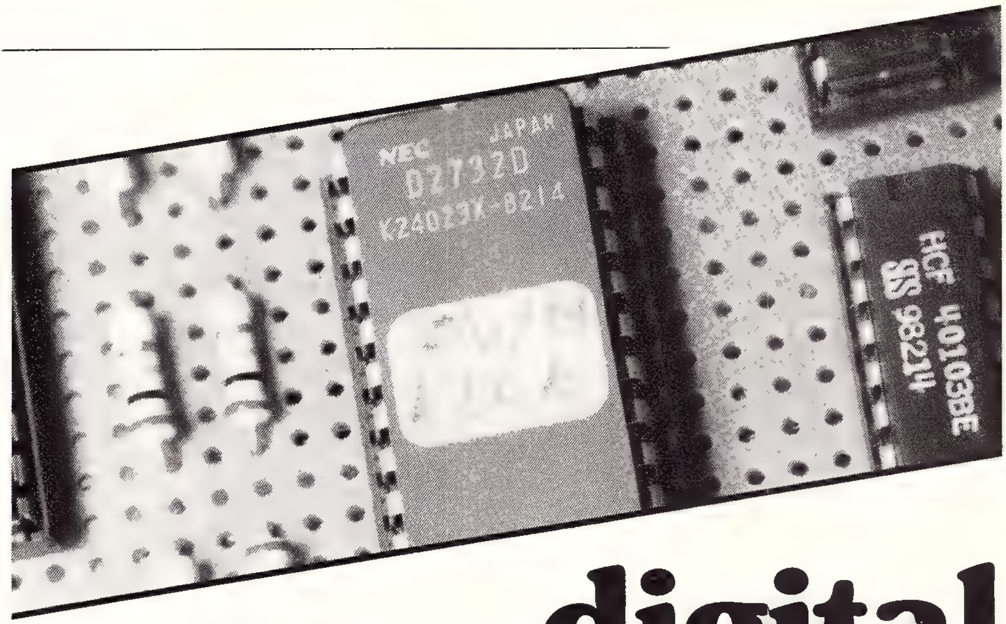




digital oscillators

enthusiasts
for music

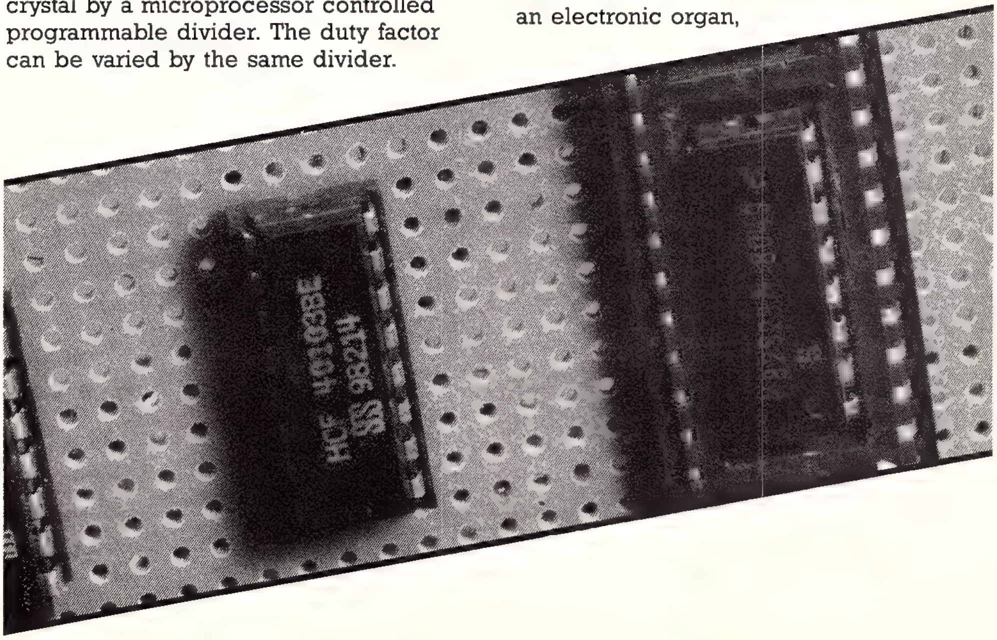
One of the real problems in electronic organs, synthesizers, and other polyphonic instruments is the stability of the oscillators, and the more oscillators there are, the more important tight tolerances become. Every hobbyist who has ever worked on a circuit containing a number of oscillators will know what we mean. One of the methods used to solve (or avoid) this problem is the use of digital techniques and a crystal to determine the frequency. Unfortunately, this procedure brings with it a fixed phase relation between separate signals, which detracts from the naturalness of the sounds. As we were not satisfied with this, we designed three circuits that may be used to replace the voltage-controlled oscillator (VCO) in an existing design, or that may form the basis of a new design.

The duty factor of a digital (pulse) signal is the ratio of the pulse width to the pulse spacing. It is sometimes, quite wrongly, called the duty cycle.

In this article, a digitally controlled oscillator, DCO, is a circuit that generates rectangular signals with fixed or variable duty factor, the frequency of which is determined by a quartz crystal. The value of that frequency is related to that of the crystal by a microprocessor controlled programmable divider. The duty factor can be varied by the same divider.

A first approach

Designing a DCO is no simple matter, not only in view of the theory involved, but also because of the sheer number of channels needed in a polyphonic musical instrument, such as an electronic organ,



tone = a musical sound consisting of a pure note (UK)
= single sound of a given pitch and duration (USA)

note = single sound of a given pitch and duration (UK)
= a musical sound consisting of a pure note (USA)

1

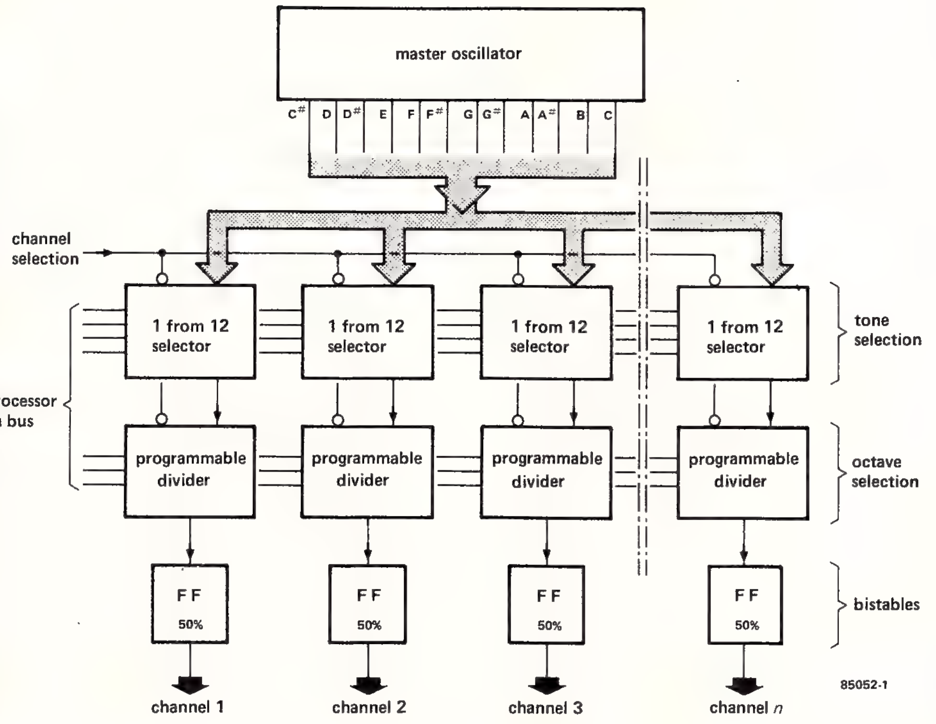


Figure 1. Block schematic diagram of a digital oscillator that may be the basis for a polyphonic musical instrument.

synthesizer, or piano. A single DCO is hardly ever encountered.

The schematic diagram of a possible DCO is shown in figure 1. The master oscillator generates the twelve tones of an octave from which one is selected. The frequency of that tone is divided by 1, 2, 3. . .*n* to determine the octave number above or below middle C (261.63 Hz). The duty factor of the resulting signal is fixed at 50 per cent by a bistable, after which the signal is fed to one of *n* channels. Selection of the wanted tone, octave, and channel is effected by a microprocessor.

The detailed circuit of one channel is given in figure 2: this must, of course, be duplicated as many times as there are channels required. The 74LS150 is used as a 1 from 12 decoder controlled by data lines $D_0 \ldots D_3$. The binary input to these lines determines which of the 12 frequencies applied to inputs $E_0 \ldots E_{11}$ will be fed to pin 10. This output signal is taken to synchronous down-counter IC_4, which is used here as a programmable divider.

The divisor is determined by the information present on the microprocessor's $D_4 \ldots D_6$ data lines. This information is first converted to a digital value by IC_3 and results in at least one of outputs 0. . .7 being active at any one time. This produces preset values, and divisors, of: 1, 2, 4, 8, 16, 32, 64, and 128. Lines $D_4 \ldots D_6$ enable the required octave to be selected. To clarify all this, figure 3 shows some down-count cycles. The longer the down-count takes after $\overline{APE}$ has become active to reach zero ($\overline{ZD}$ active), the lower the frequency at the input. The bistable provides a train of very short negative pulses which have a duty factor of 50 per cent (i.e., they are square waves).

The circuit of figure 2 does not generate any signal, but is, rather, a sort of programmable interface between the microprocessor and the master oscillator. The master oscillator, the circuit of which is shown in figure 4, has buffered outputs which can, therefore, be applied to one or more 1 from 12 decoders (figure 2). The set-up of figure 5 is quite different from

2

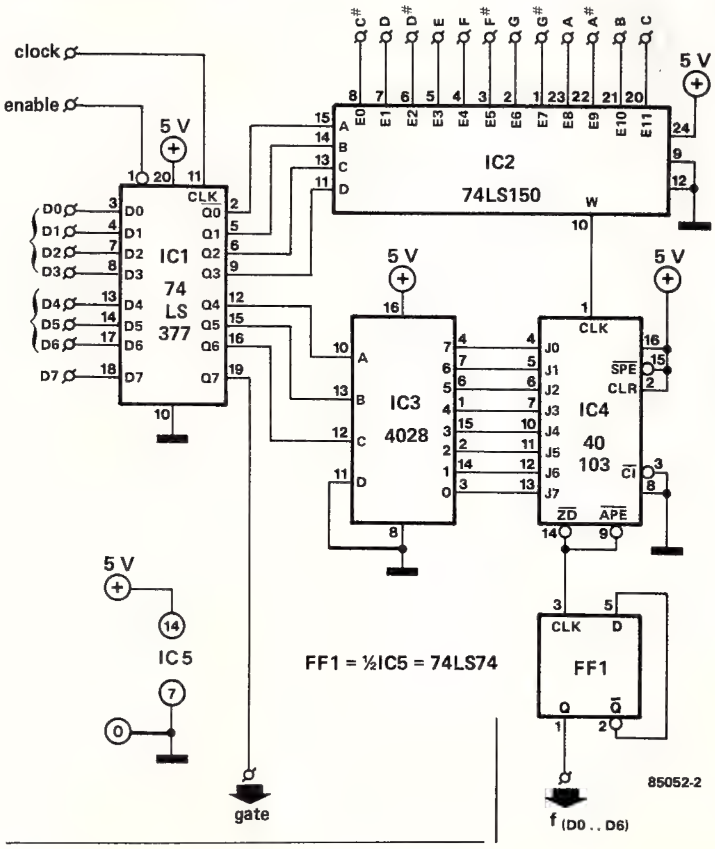


Figure 2. Each channel in figure 1 requires a circuit as shown here. The tone and the octave are selected via the data bus.

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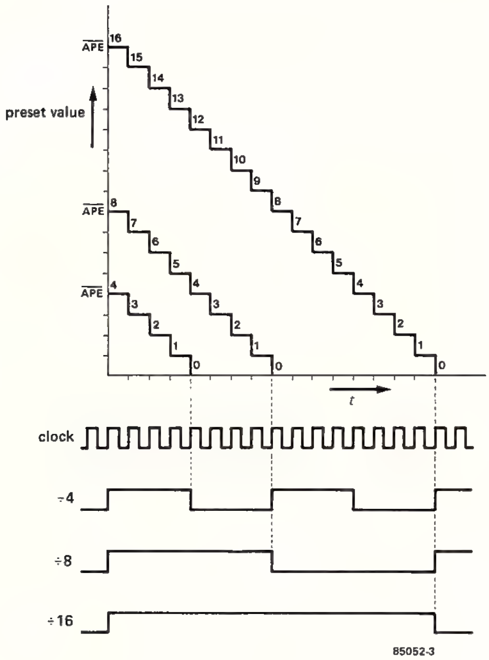

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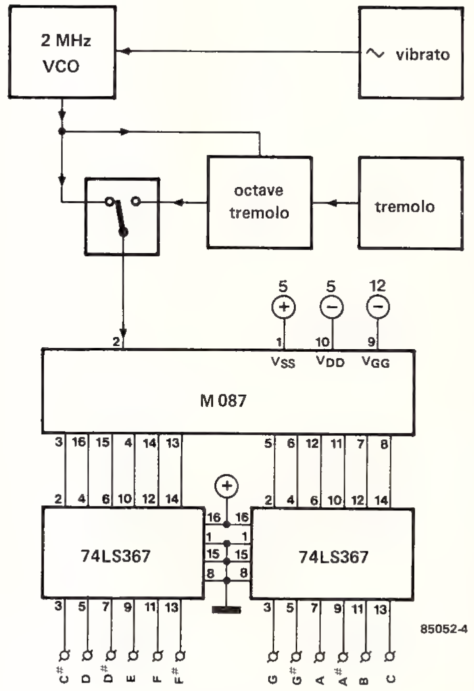

Figure 3. The principle of the 40103 divider. The higher the preset value, the longer the counting process, and the lower the frequency.

Figure 4. The M087 is a master oscillator that generates the twelve tones of an octave. It may be driven by a crystal oscillator, as here, or by a voltage-controlled oscillator, possibly in conjunction with a vibrato and tremolo circuit.

Figure 5. An alternative for one channel from figure 1. Two programmable dividers ensure selection of tones and octaves.

Figure 6. The circuit diagram of the set-up in figure 5. The clock frequency is equal to the highest tone of the highest octave.

that in figure 1: it has no master oscillator, but simply a clock input, the frequency of which is a multiple of the highest tone in the top octave. This frequency is applied to two programmable dividers that select the octave and tone respectively. The circuit of this arrangement is shown in figure 6. The octave is selected by the microprocessor via retriggerable buffer IC_1 and then applied to a divider formed by IC_2 and IC_3. The frequency of the output of IC_3 is a multiple of the tone which will be selected by programmable divider IC_5.

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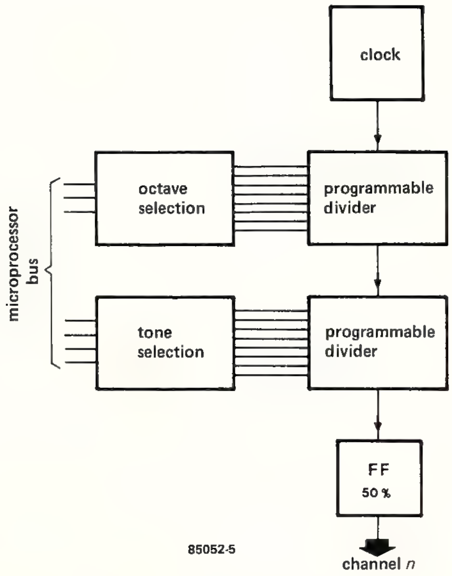

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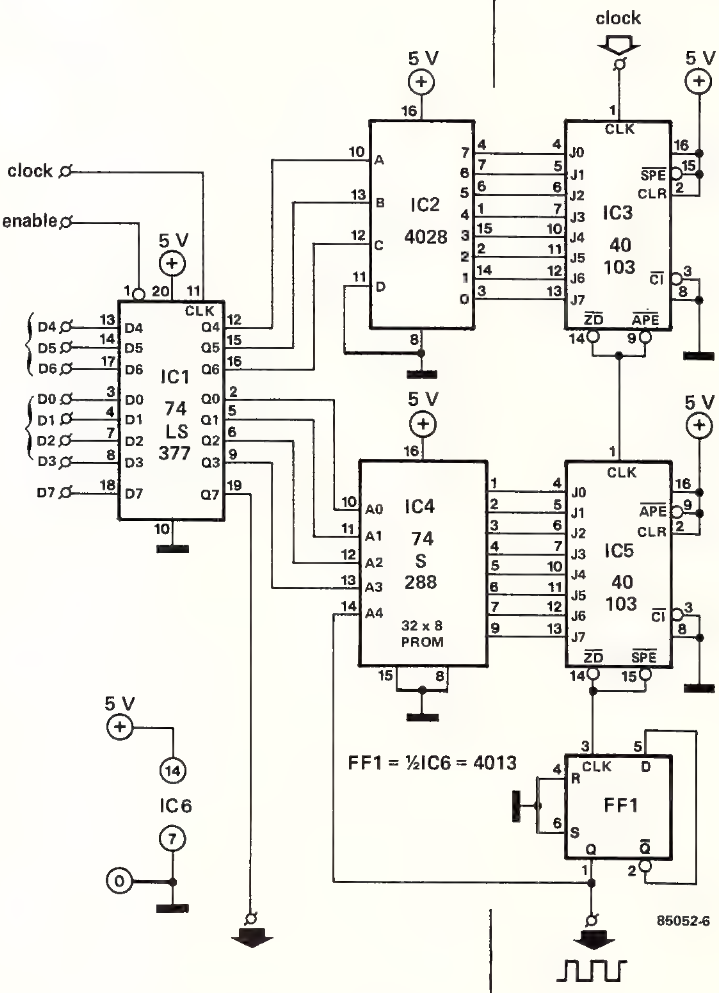

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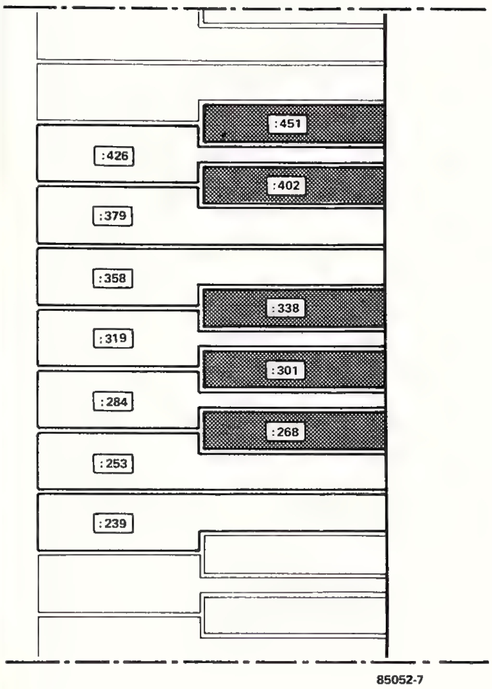
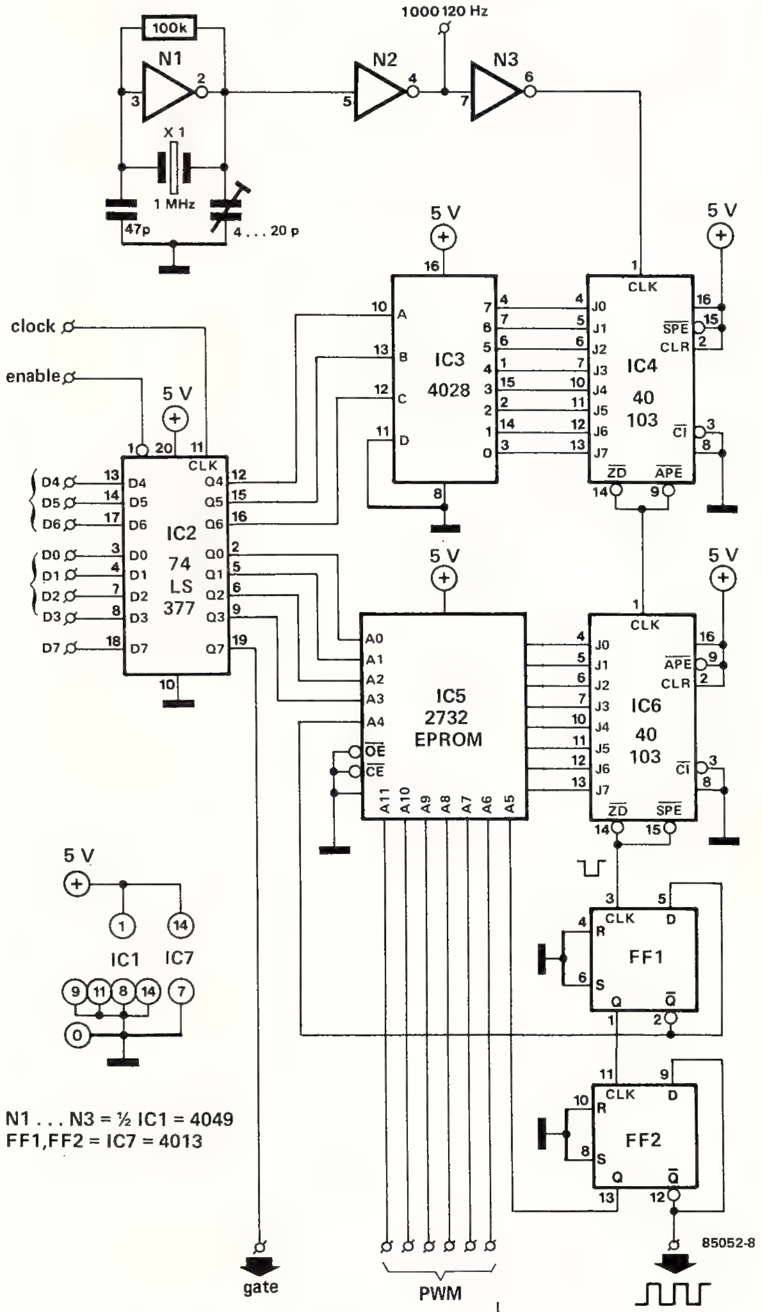


The ratio between successive tones in an octave is the 12th power root of 2, which is very nearly equal to 1.059. These ratios are provided as a matter of course in an IC like the M087, but they can also be obtained from the set-up in figure 6, consisting of divider IC$_5$, PROM IC$_4$, and bistable FF$_1$.

The divisors required to resolve an octave into its constituent twelve tones are shown in figure 7. The 40103 on its own can cope neither with numbers larger than 256, nor with odd numbers, but, in conjunction with a PROM, IC$_4$, and the bistable, it can. The basic divide information is selected via $D_0 \ldots D_3$, which are connected to address lines $A_0 \ldots A_3$ of the PROM via IC$_1$. By feeding back output Q of the bistable to input A_4 of the PROM, it becomes possible to split the divide process into two. During one part of the count cycle the output of the bistable is logic low, when the lowest sixteen addresses of the PROM are selected. A certain preset value for IC$_5$ then exists at the memory location selected by $D_0 \ldots D_3$. After this value has been counted, the bistable toggles, and the highest sixteen addresses of the PROM are selected. Lines $A_0 \ldots A_3$ do not change, so that the preset value is then sixteen places higher than previously. After this preset value has been counted, the bistable toggles again, and the whole process starts afresh. The contents of the PROM are given in table 1. Note a small but important point here: because the $\overline{\text{SPE}}$ input is now used as the preset enable instead of the $\overline{\text{APE}}$ input, the divisor is the preset value plus 1. Therefore, the data values in table 1 are one lower than the wanted divisors.

8



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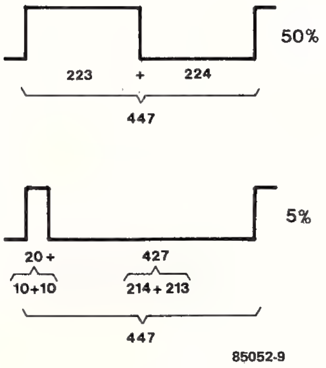


Figure 7. The divisors for resolving an octave into its twelve constituent tones.

Figure 8. This extended DCO provides twelve tones over eight octaves. The duty factor may be set between five and 50 per cent in sixty-four steps.

Figure 9. To achieve a variable duty factor, it is necessary to divide both count cycles once more: there are thus four count cycles per period.

Table 1.

A4	A3	A2	A1	A0	DATA (HEX)	
0	0	0	0	0	E0	first part of the count cycle
0	0	0	0	1	D4	
0	0	0	1	0	C8	
0	0	0	1	1	BC	
0	0	1	0	0	B2	
0	0	1	0	1	A8	
0	0	1	1	0	9E	
0	0	1	1	1	95	
0	1	0	0	0	8D	
0	1	0	0	1	85	
0	1	0	1	0	7D	
0	1	0	1	1	76	
1	0	0	0	0	EI	second part of the count cycle
1	0	0	0	1	14	
1	0	0	1	0	C8	
1	0	0	1	1	BD	
1	0	1	0	0	B2	
1	0	1	0	1	A8	
1	0	1	1	0	9F	
1	0	1	1	1	96	
1	1	0	0	0	8D	
1	1	0	0	1	85	
1	1	0	1	0	7E	
1	1	0	1	1	77	

Table 1. The content of the PROM in figure 6.

If we take as an example divisor 239 (which selects the highest tone in an octave), $A_0 \ldots A_3$ are logic 0. When A_4 is low, the output of the PROM is 119 (77_{HEX}), and when it is high, the output of the PROM is 120 (78_{HEX}). The sum of the two is not a totally symmetrical square wave, but the very small deviation does not really matter.

If you want to experiment, it is, of course, possible to vary the ratios by programming different divisors. The phase relation between the harmonic frequencies is then also different, and this will affect the timbre.

The final step

An extended version of the previous circuit is shown is figure 8. Here again, the main modification lies in the tone divider. The memory range of the PROM has been expanded greatly, which enables the use of digitally controlled pulse-width modulation. The total divide time remains as before, but the divisors for the logic 1 and logic 0 periods are different. If we take as an example a divisor of 447, a duty factor of, near enough, 50 per cent will split this into 223 and 224. If, however, a duty factor of 5 per cent is wanted, the first part becomes 20 (as the logic 1 can last only one tenth as long as before), and the second 427. Once again, we have the problem of having to divide the second part into two (because the 40103 stil cannot cope with numbers larger than 256). Therefore, a second bistable, FF_2, has been added; its Q output is taken to input A_5 of PROM IC_5. In this way, a further division of both the first and the second part of the count cycle is effected.

Figure 9 illustrates what happens when a duty factor of 5 per cent is wanted. The divisors are 10 (1a), 10 (1b), 214 (2a), and 213 (2b). What was said earlier on about the relation between the sum of the stored preset values and the actual divisor is true here also. That is, preset value plus 1 is divisor. As this happens here four times, we must add 4 to the sum of 447 to obtain

10

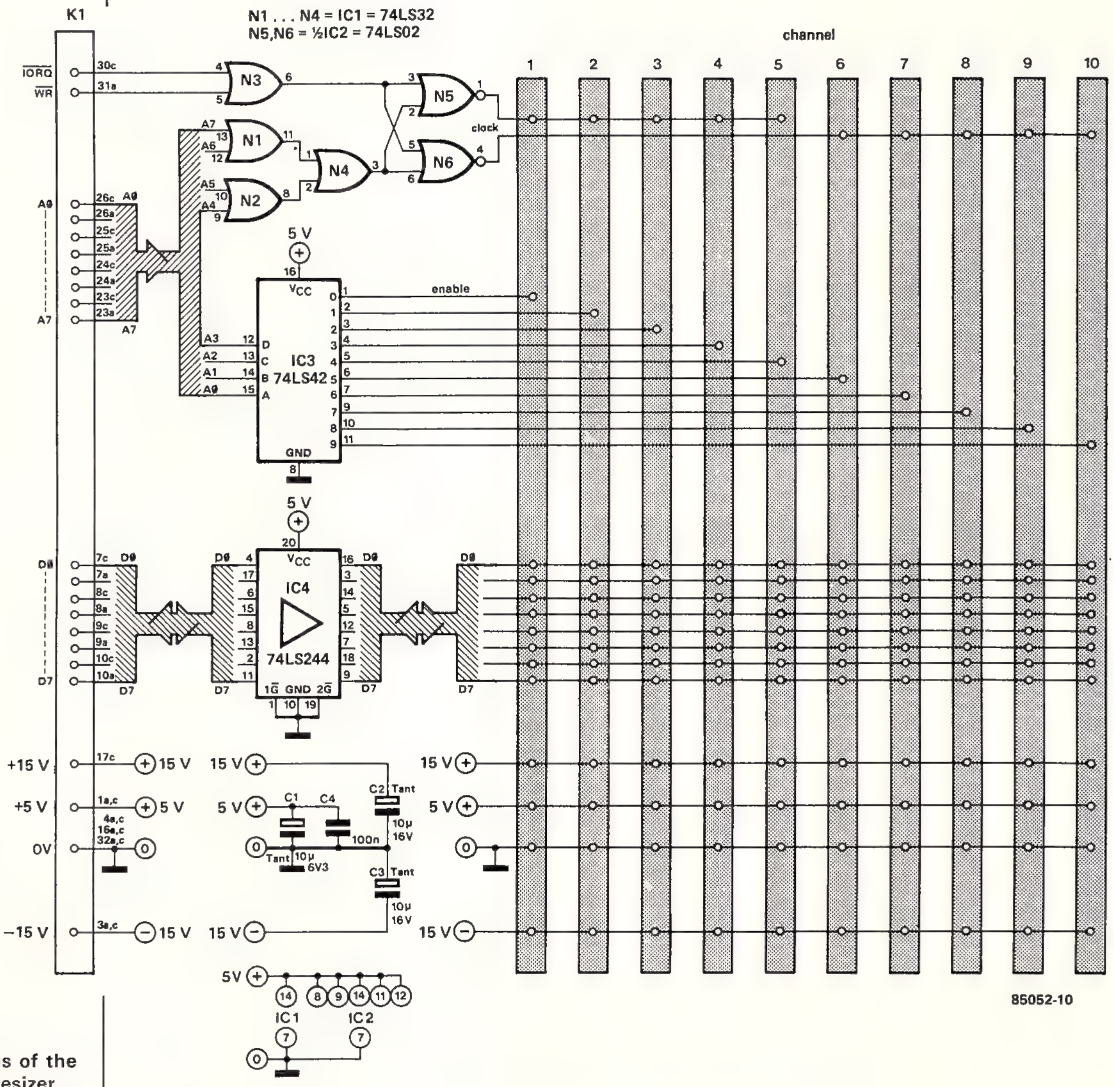


Figure 10. The bus of the polyphonic synthesizer can be connected to the DCOs in figure 2, 6, and 8 without any modification.

Table 2.

```
      0  1  2  3  4  5  6  7  8  9  A  B
000: 6F 69 63 5D 58 53 4E 4A 46 42 3E 3A
010: 70 6A 64 5E 59 54 4F 4B 46 42 3F 3B
020: 70 69 63 5E 58 53 4F 4A 46 42 3E 3B
030: 70 6A 64 5E 59 54 4F 4A 46 42 3E 3B
040: 6E 68 62 5C 57 52 4D 49 45 41 3D 39
050: 72 6B 65 60 5A 55 50 4C 47 43 40 3C
060: 71 6B 65 5F 5A 54 50 4B 47 43 3F 3C
070: 6E 68 62 5C 57 53 4E 49 45 41 3D 3A
080: 6C 66 60 5B 56 51 4C 48 44 40 3C 39
090: 73 6D 67 61 5B 56 52 4D 48 44 41 3D
0A0: 73 6C 66 60 5B 56 51 4C 48 44 40 3C
0B0: 6D 67 61 5B 56 51 4C 48 44 40 3C 39
0C0: 6A 65 5F 59 54 50 4B 47 43 3F 3B 38
0D0: 75 6E 68 62 5D 57 53 4E 49 45 41 3E
0E0: 75 6E 68 62 5C 57 52 4D 49 45 41 3D
0F0: 6B 65 5F 5A 55 50 4B 47 43 3F 3C 38
100: 69 63 5E 58 53 4E 4A 45 42 3E 3A 37
110: 77 70 69 64 5E 59 54 4F 4A 46 42 3F
120: 76 6F 69 63 5D 58 53 4F 4A 46 42 3E
130: 69 64 5E 58 54 4F 4A 46 42 3E 3B 37
140: 67 62 5C 56 52 4D 49 44 41 3D 39 36
150: 78 71 6B 65 5F 5A 55 50 4B 47 43 40
160: 78 71 6A 65 5F 59 54 50 4B 47 43 3F
170: 68 62 5D 57 52 4E 49 45 41 3D 3A 36
180: 66 60 5B 55 51 4C 47 43 40 3C 38 35
190: 7A 73 6C 66 60 5B 56 51 4C 48 44 40
1A0: 79 72 6C 66 60 5A 56 51 4C 47 44 40
1B0: 66 61 5B 56 51 4D 48 44 40 3D 39 36
1C0: 64 5F 59 54 4F 4B 46 42 3F 3B 37 34
1D0: 7C 74 6E 68 62 5C 57 52 4D 49 45 41
1E0: 7B 74 6D 67 61 5C 57 52 4D 48 45 41
1F0: 64 5F 5A 54 50 4B 47 43 3F 3C 38 35
200: 62 5D 58 52 4E 4A 45 41 3E 3A 37 33
210: 7D 76 6F 69 63 5D 58 53 4E 4A 46 42
220: 7D 75 6F 69 62 5D 58 53 4E 49 45 42
230: 63 5E 58 53 4F 4A 46 42 3E 3B 37 34
240: 61 5C 56 51 4D 48 44 40 3D 39 36 33
250: 7F 77 71 6A 64 5F 59 54 4F 4B 47 43
260: 7E 77 70 6A 64 5E 59 54 4F 4A 46 42
270: 61 5C 57 52 4D 49 45 41 3D 3A 36 33
280: 5F 5A 55 50 4B 47 43 3F 3C 38 35 32
290: 80 79 72 6C 66 60 5B 55 50 4C 48 44
2A0: 80 78 72 6B 65 5F 5A 55 50 4B 47 43
2B0: 60 5B 55 50 4C 48 43 40 3C 39 35 32
2C0: 5E 59 53 4E 4A 46 42 3E 3B 37 34 31
2D0: 82 7A 74 6D 67 61 5C 57 51 4D 49 45
2E0: 81 7A 73 6D 66 61 5B 56 51 4C 48 44
2F0: 5E 59 54 4F 4B 46 42 3E 3B 38 34 31
300: 5C 57 52 4D 49 45 41 3D 3A 36 33 30
310: 84 7C 75 6E 68 62 5D 58 52 4E 4A 45
320: 83 7C 74 6E 68 62 5C 57 52 4D 49 45
330: 5C 57 53 4E 49 45 41 3D 3A 37 33 31
340: 5A 55 51 4C 48 44 3F 3C 39 35 32 2F
350: 85 7E 76 70 69 63 5E 59 53 4F 4A 46
360: 85 7D 76 6F 69 63 5E 58 53 4E 4A 46
370: 5B 56 51 4C 48 44 40 3C 39 36 33 30
380: 59 54 4F 4A 46 42 3E 3B 38 34 31 2E
390: 87 7F 78 71 6B 65 5F 5A 54 50 4B 47
3A0: 86 7F 77 71 6A 64 5F 59 54 4F 4B 47
3B0: 59 54 50 4B 47 43 3F 3B 38 35 32 2F
3C0: 57 52 4E 49 45 41 3D 3A 37 33 30 2D
3D0: 88 81 79 73 6C 66 60 5B 55 51 4C 48
3E0: 88 80 79 72 6B 65 60 5A 55 50 4C 48
3F0: 58 53 4E 49 46 42 3E 3A 37 34 31 2E
400: 56 51 4C 48 44 40 3C 39 36 32 2F 2D
410: 8A 82 7B 74 6D 67 61 57 56 52 4D 49
420: 39 82 7A 73 6D 67 61 5B 56 51 4D 48
430: 56 51 4D 48 44 40 3D 39 36 33 30 2D
440: 54 4F 4B 46 43 3F 3B 38 35 31 2E 2C
450: 8C 84 7C 75 6E 68 63 5D 57 53 4E 4A
460: 8B 83 7C 75 6E 68 62 5C 57 52 4E 49
470: 54 50 4B 47 43 3F 3B 38 35 32 2F 2C
480: 52 4E 49 45 41 3E 3A 36 33 31 2E 2B
490: 8D 85 7E 77 70 69 64 5E 59 53 4F 4B
4A0: 8D 85 7D 76 6F 69 63 5E 58 53 4E 4A
4B0: 53 4E 4A 45 42 3E 3A 37 34 31 2E 2B
4C0: 51 4C 48 44 40 3C 39 35 32 30 2D 2A
4D0: 8F 87 7F 78 71 6B 65 5F 5A 54 50 4B
4E0: 8E 86 7F 77 71 6A 64 5F 59 54 4F 4B
4F0: 51 4D 48 44 40 3D 39 36 33 30 2D 2B
500: 4F 4B 47 42 3F 3B 38 34 31 2F 2C 29
510: 90 88 80 79 72 6C 66 60 5B 55 51 4C
520: 90 88 80 79 72 6B 65 60 5A 55 50 4C
530: 50 4B 47 43 3F 3C 38 35 32 2F 2C 2A
540: 4D 49 45 41 3D 3A 36 33 30 2E 2B 28
550: 92 8A 82 7B 74 6D 67 61 5C 56 52 4D
560: 92 89 81 7A 73 6D 67 61 5B 56 51 4D
570: 4E 4A 46 41 3E 3A 37 34 31 2E 2B 29
580: 4C 48 44 40 3C 39 35 32 2F 2D 2A 28
590: 94 8B 83 7C 75 6E 68 62 5D 57 53 4E
5A0: 93 8B 83 7B 74 6E 68 62 5C 57 52 4D
5B0: 4C 48 44 40 3D 39 36 33 30 2D 2A 28
5C0: 4A 46 42 3E 3B 37 34 31 2E 2C 29 27
5D0: 95 8D 85 7D 76 70 69 63 5E 58 53 4F
5E0: 95 8C 84 7D 76 6F 69 63 5D 58 53 4E
5F0: 4B 47 43 3F 3B 38 35 32 2F 2C 2A 27
600: 49 45 41 3D 3A 36 33 30 2D 2B 28 26
610: 97 8E 86 7F 77 71 6B 64 5F 59 54 50
620: 96 8E 86 7E 77 70 6A 64 5E 59 54 4F
630: 49 45 41 3D 3A 37 33 31 2E 2B 29 26
640: 47 43 3F 3B 38 35 32 2F 2C 2A 27 25
650: 98 90 88 80 79 72 6C 66 60 5A 55 51
660: 98 8F 87 80 78 71 6B 65 5F 5A 55 50
670: 48 44 40 3C 39 36 32 2F 2D 2A 28 25
680: 45 42 31 3A 37 34 31 2E 2B 29 26 24
690: 9A 91 89 81 7A 73 6D 67 61 5B 56 51
6A0: 9A 91 89 81 79 73 6C 66 60 5B 56 51
6B0: 46 42 3E 3B 38 34 31 2E 2C 29 27 25
6C0: 44 40 3C 39 36 33 30 2D 2A 28 25 23
6D0: 9C 93 8B 83 7B 74 6E 68 62 5C 57 52
6E0: 9B 92 8A 82 7B 74 6D 67 61 5C 57 52
6F0: 44 41 3D 39 36 33 30 2D 2B 28 26 24
700: 42 3F 3B 37 34 31 2E 2C 29 27 25 22
710: 9D 94 8C 84 7D 76 6F 69 63 5D 58 53
720: 9D 94 8B 84 7C 75 6F 68 62 5D 57 53
730: 43 3F 3C 38 35 32 2F 2C 2A 27 25 23
740: 41 3D 3A 36 33 30 2D 2B 28 26 24 22
750: 9F 96 8D 85 7E 77 70 6A 64 5E 59 54
760: 9E 95 8D 85 7D 76 70 69 63 5E 58 53
770: 41 3E 3A 37 34 31 2E 2B 29 26 24 22
780: 3F 3C 38 35 32 2F 2C 2A 27 25 23 21
790: A0 97 8F 87 7F 78 71 6B 65 5F 5A 55
7A0: A0 97 8E 86 7F 77 71 6A 64 5E 59 54
7B0: 40 3C 39 35 32 30 2D 2A 28 26 23 21
7C0: 3D 3A 37 33 31 2E 2B 29 26 24 22 20
7D0: A2 99 90 88 80 79 72 6C 66 60 5B 56
7E0: A2 98 90 88 80 79 72 6B 65 5F 5A 55
7F0: 3E 3B 37 34 31 2E 2C 29 27 25 22 20
800: 3C 39 35 32 2F 2D 2A 27 25 23 21 1F
810: A4 9A 92 89 82 7A 74 6D 67 61 5C 56
820: A3 9A 91 89 81 7A 73 6D 66 60 5B 56
830: 3C 39 36 33 30 2D 2A 28 26 24 21 20
840: 3A 37 34 31 2E 2B 29 26 24 22 20 1E
850: A5 9C 93 8B 83 7C 75 6E 68 62 5C 57
860: A5 9B 93 8A 82 7B 74 6E 67 61 5C 57
870: 3B 38 34 31 2F 2C 29 27 25 23 21 1F
880: 39 36 32 2F 2D 2A 28 25 23 21 1F 1D
890: A7 9D 95 8C 84 7D 76 6F 69 63 5D 58
8A0: A6 9D 94 8C 84 7C 75 6F 68 62 5D 58
8B0: 39 36 33 30 2D 2B 28 26 24 22 20 1E
8C0: 37 34 31 2E 2B 29 26 24 22 20 1E 1C
8D0: A9 9F 96 8E 86 7E 77 70 6A 64 5E 59
8E0: A8 9F 96 8D 85 7E 77 70 69 63 5E 59
8F0: 37 34 31 2E 2C 29 27 25 23 21 1F 1D
900: 35 32 30 2D 2A 28 25 23 21 1F 1D 1C
910: AA A1 97 8F 87 7F 78 71 6B 65 5F 5A
920: AA A0 97 8E 86 7F 78 71 6A 64 5F 59
930: 36 33 30 2D 2B 28 26 24 22 20 11 1C
940: 34 31 2E 2B 29 27 24 22 20 1E 1C 1B
950: AC A2 99 90 88 80 79 72 6C 66 60 5B
960: AB A2 98 90 88 80 79 72 6B 65 60 5A
970: 34 31 2F 2C 29 27 25 23 21 1F 1D 1B
980: 32 2F 2D 2A 28 25 23 21 1F 1D 1C 1A
990: AD A4 9A 92 89 82 7A 73 6D 67 61 5C
9A0: AD A3 9A 91 89 81 7A 73 6C 66 60 5B
9B0: 33 30 2D 2A 28 26 24 22 20 1E 1C 1A
9C0: 31 2E 2B 29 26 24 22 20 1E 1C 1B 19
9D0: AF A5 9C 93 8B 83 7C 75 6E 68 62 5C
9E0: AE A5 9B 92 8A 82 7B 74 6D 67 61 5C
9F0: 31 2E 2C 29 27 25 22 20 1F 1D 1B 1A
A00: 2F 2C 2A 27 25 23 21 1F 1D 1B 1A 18
A10: B1 A7 9D 94 8C 84 7D 76 6F 69 63 5D
A20: B0 A6 9D 94 8B 84 7C 75 6E 68 62 5D
A30: 2F 2D 2A 28 26 23 21 1F 1E 1C 1A 19
A40: 2D 2B 28 26 24 22 20 1E 1C 1B 19 17
A50: B2 A8 9F 96 8D 85 7E 77 70 69 64 5E
A60: B2 A8 9E 95 8D 85 7D 76 6F 69 63 5E
A70: 2E 2B 29 26 24 22 20 1E 1D 1B 19 18
A80: 2C 29 27 25 23 21 1F 1D 1B 1A 18 17
A90: B4 AA A0 97 8E 86 7F 78 71 6A 65 5F
AA0: B3 A9 A0 96 8E 86 7E 77 70 6A 64 5E
AB0: 2C 2A 27 25 23 21 1F 1D 1C 1A 18 17
AC0: 2A 28 26 23 21 1F 1D 1C 1A 19 17 16
AD0: B5 AB A1 98 90 88 80 79 72 6B 65 60
AE0: B5 AB A1 98 8F 87 80 78 71 6B 65 5F
AF0: 2B 28 26 24 22 20 1E 1C 1B 19 18 16
B00: 29 26 24 22 20 1E 1C 1B 19 18 16 15
B10: B7 AD A3 9A 91 89 81 7A 73 6C 66 61
B20: B6 AC A2 99 91 88 81 79 72 6C 66 60
B30: 29 27 25 22 20 1F 1D 1B 1A 18 17 15
B40: 27 25 23 20 1F 1D 1B 1A 18 17 15 14
B50: B9 AE A4 9B 92 8A 82 7B 74 6D 67 62
B60: B8 AE A4 9B 92 8A 82 7A 73 6D 67 61
B70: 27 25 23 21 1F 1D 1C 1A 19 17 16 14
B80: 25 23 21 1F 1D 1C 1A 18 17 16 14 13
B90: BA B0 A6 9C 94 8B 83 7C 75 6E 68 62
BA0: BA AF A5 9C 93 8B 83 7C 74 6E 68 62
BB0: 26 24 22 20 1E 1C 1B 19 18 16 15 14
BC0: 24 22 20 1E 1C 1B 19 17 16 15 13 12
BD0: BC B1 A7 9E 95 8C 85 7D 76 6F 69 63
BE0: BB B1 A7 9D 94 8C 84 7D 75 6F 69 63
BF0: 24 22 20 1E 1D 1B 19 18 17 15 14 13
C00: 22 20 1E 1C 1B 19 18 16 15 14 13 11
C10: BD B3 A9 9F 96 8E 86 7E 77 70 6A 64
C20: BD B2 A8 9F 96 8D 85 7E 76 70 69 64
C30: 23 21 1F 1D 1B 1A 18 17 16 14 13 12
C40: 20 1F 1D 1B 1A 18 17 15 14 13 12 11
C50: BF B4 AA A0 97 8F 87 7F 78 71 6B 65
C60: BF B4 AA A0 97 8E 86 7F 77 71 6A 64
C70: 21 1F 1D 1C 1A 19 17 16 15 13 12 11
C80: 1F 1D 1B 1A 18 17 15 14 13 12 11 10
C90: C1 B6 AC A2 99 90 88 80 79 72 6C 66
CA0: C0 B5 AB A1 98 90 88 80 78 72 6B 65
CB0: 1F 1E 1C 1A 19 17 16 15 14 12 11 10
CC0: 1D 1C 1A 18 17 16 14 13 12 11 10 0F
CD0: C2 B7 AD A3 9A 91 89 81 7A 73 6D 67
CE0: C2 B7 AC A3 99 91 89 81 79 73 6C 66
CF0: 1E 1C 1B 19 18 16 15 14 13 11 10 0F
D00: 1C 1A 19 17 16 14 13 12 11 10 0F 0E
D10: C4 B9 AE A4 9B 93 8A 82 7B 74 6E 67
D20: C3 B8 AE A4 9B 92 8A 82 7A 74 6D 67
D30: 1C 1B 19 18 16 15 14 13 12 10 0F 0F
D40: 1A 19 17 16 14 13 12 11 10 0F 0E 0D
D50: C5 BA B0 A6 9D 94 8B 84 7C 75 6E 68
D60: C5 BA AF A5 9C 93 8B 83 7C 74 6E 68
D70: 1B 19 18 16 15 14 13 11 10 10 0F 0E
D80: 18 17 16 14 13 12 11 10 0F 0E 0D 0C
D90: C7 BC B1 A7 9E 95 8D 85 7D 76 6F 69
DA0: C7 BB B1 A7 9D 94 8C 84 7D 75 6F 69
DB0: 19 18 16 15 14 13 11 10 0F 0F 0E 0D
DC0: 17 16 14 13 12 11 10 0F 0E 0D 0C 0B
DD0: C9 BD B3 A9 9F 96 8E 86 7E 77 70 6A
DE0: C8 BD B2 A8 9F 96 8D 85 7E 76 70 6A
DF0: 17 16 15 13 12 11 10 0F 0E 0E 0D 0C
E00: 15 14 13 12 11 10 0F 0E 0D 0C 0B 0B
E10: CA BF B4 AA A0 97 8F 87 7F 78 71 6B
E20: CA BE B4 A9 A0 97 8E 86 7F 77 71 6A
E30: 16 15 13 12 11 10 0F 0E 0D 0D 0C 0B
E40: 14 13 11 10 0F 0E 0E 0D 0C 0B 0A 0A
E50: CC C0 B6 AB A2 99 90 88 80 79 72 6C
E60: CB C0 B5 AB A1 98 8F 87 80 78 72 6B
E70: 14 13 12 11 10 0F 0E 0D 0C 0C 0B 0A
E80: 12 11 10 0F 0E 0D 0C 0C 0B 0A 0A 09
E90: CD C2 B7 AD A3 9A 91 89 81 7A 73 6D
EA0: CD C1 B7 AC A2 99 91 88 81 79 72 6C
EB0: 13 12 10 0F 0F 0E 0D 0C 0B 0B 0A 09
EC0: 10 0F 0F 0E 0D 0C 0B 0B 0A 09 09 08
ED0: CF C4 B8 AE A4 9B 92 8A 82 7B 74 6D
EE0: CF C3 B8 AD A4 9A 92 89 82 7A 73 6D
EF0: 11 10 0F 0E 0D 0D 0C 0B 0A 0A 09 09
F00: 0F 0E 0D 0C 0C 0B 0A 09 09 08 08 07
F10: D1 C5 BA AF A5 9C 93 8B 83 7C 75 6E
F20: D0 C5 B9 AF A5 9C 93 8B 83 7B 74 6E
F30: 0F 0E 0E 0D 0C 0B 0B 0A 09 09 08 08
F40: 0D 0C 0C 0B 0A 0A 09 08 08 07 07 06
F50: D2 C7 BB B1 A7 9D 95 8C 84 7D 76 6F
F60: D2 C6 BB B0 A6 9D 94 8C 84 7C 75 6F
F70: 0E 0D 0C 0B 0B 0A 09 09 08 08 07 07
F80: 0C 0B 0A 0A 09 08 08 07 07 06 06 06
F90: D4 C8 BD B2 A8 9F 96 8D 85 7E 77 70
FA0: D3 C8 BC B1 A8 9E 95 8D 85 7D 76 6F
FB0: 0C 0B 0B 0A 09 09 08 08 07 07 06 06
FC0: 0A 09 09 08 08 07 07 06 06 05 05 05
FD0: D6 CA BE B3 A9 A0 97 8E 86 7F 77 71
FE0: D5 C9 BE B3 A9 9F 96 8E 86 7E 77 70
FF0: 0A 0A 09 09 08 08 07 07 06 06 06 05
```

Table 2. The content of the EPROM in figure 8.

he actual divisor of 451. This selects the owest tone in an octave.

t is, therefore, possible to use pulse-width modulation (PWM) by applying the modulating signal in digital form (6 bits) to he highest six address lines of the EPROM. This memory has been programmed such that the duty factor can be varied from 50 per cent to five per cent in $2^6=64$ steps. Each step thus represents 0.7 per cent of the duty factor. Note that A_{11} provides the MSB (most significant bit).

Finally

The circuit of figure 8 enables the selection via a microprocessor of one tone from up to eight octaves, with the possibility of pulse-width modulation, in one channel. If you want to replace the VCO in the *polyphonic synthesizer* (described in a number of issues of *Elektor* between October 1981 and July 1982) by the DCO, the bus layout of figure 10 may be maintained. The EPROM content is given in table 2.

In pulse-width modulation, the modulating signal is usually generated by an analogue low frequency oscillator and this must here, therefore, be followed by an analogue/digital converter. The use of the *music quantisizer* (*Elektor*, October 1983, p. 10-30) may provide further interesting musical effects. ■

the short search...

Like most of us, you must sometimes have cursed under your breath when tracing a fault took longer than building the circuit. Such an occurrence is particularly galling when you finally discover that the fault is not an electrical, but a "mechanical" defect, such as a hairline fracture in a printed circuit track, a dry soldering joint, and so on... It is unfortunately the mechanical defect that is so difficult to trace, often because the right test equipment is not available or simply too expensive.

...or the search for the short

Printed circuits are particularly prone to mechanical defects, especially when they contain many thin tracks. Finding the mechanical cause of a malfunctioning memory board, for instance, is certainly a time consuming job! Every conscientious hobbyist of course, checks his circuits carefully after completion, both visually and with a multimeter. But what do you do when you detect, say, a short-circuit and cannot locate it visually?

A simple test consists of removing all ICs from their holders in the suspected area and injecting an audio signal of about 1 kHz into the doubtful printed circuit tracks. The current consequently flowing through the tracks causes an electromagnetic field. This field can be detected with an old (but working!) recording head from a cassette or tape recorder: the output of the head is applied to a small audio amplifier terminated in a miniature loudspeaker. When the recording head is passed over the relevant track, the audio signal is audible until the short-circuit is reached. It's as simple as that!

Construction

As already stated, any old recording head may be used: frequency response and reproduction quality are of no consequence, as long as the head still works. An old cassette recorder of which the audio amplifier and loudspeaker (as well as the recording head) still work is ideal. The head is unsoldered from the recorder and fitted with a length of screened cable. The free ends of this cable are then

1

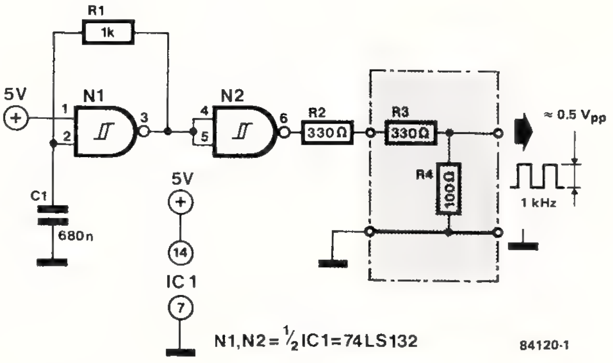


Figure 1. Simple square-wave generator with an output of about 1 kHz. The output level cannot be adjusted, but this is of little consequence, as the volume of the audio amplifier can be.

2

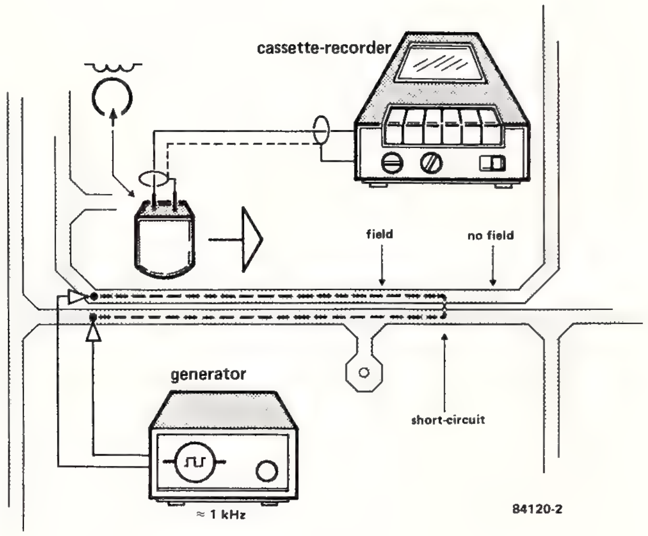


Figure 2. Example of how the search for a short-circuit may be carried out.

oldered into the position from which the ecording head was removed. And that's eally all. The head may, of course, be istened onto a small length of aluminium ibing or even an old ballpen holder to iake it easier to pass accurately over the rinted circuit tracks.

esting

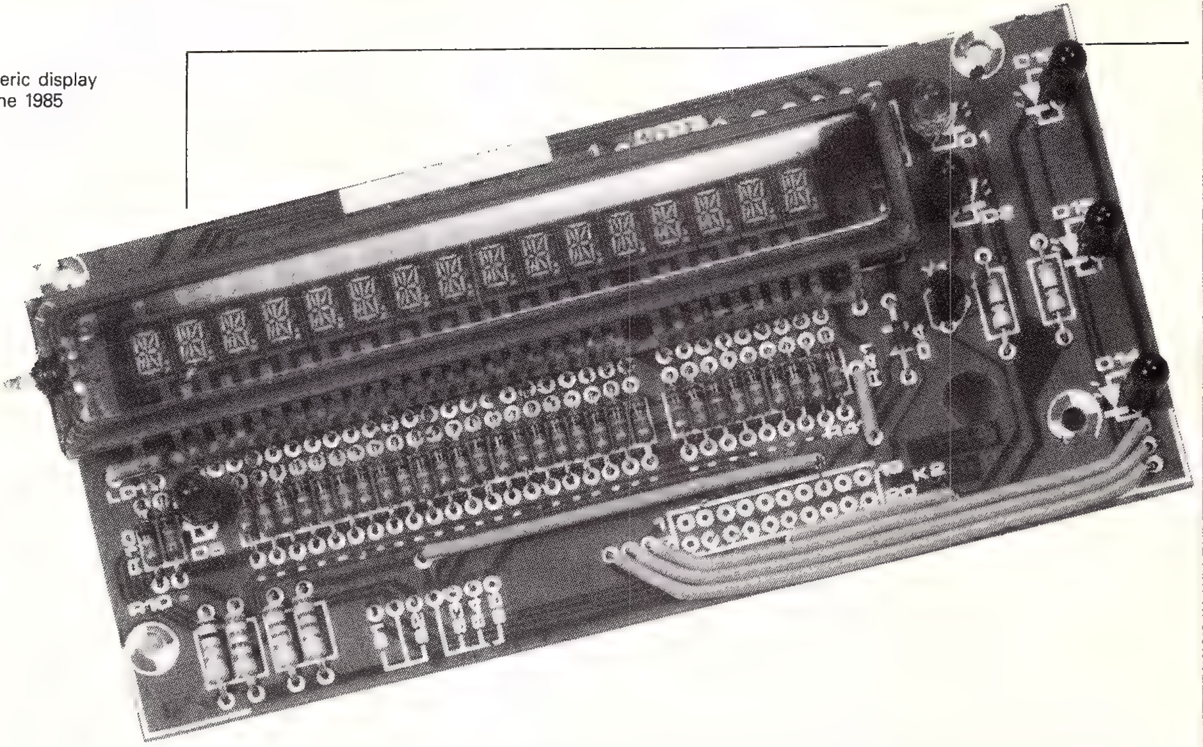
Ve can now find out what our little tester capable of. But first we need an audio ignal. If you have no a.f. generator, you iay build the simple square-wave oscil-itor shown in figure 1. If you use an xisting generator, it is recommended to onnect a 100-ohm resistor in series with s output.

hort-circuit the output of the audio gen-rator and bring it close to the recording head (but do not touch). A signal is then induced in the head which becomes audible in the loudspeaker: the volume, where possible, may now be preset as required.

Next, connect the audio generator output to the two tracks that are suspected of being shorted (see figure 2). The search becomes a little more tricky when two adjacent pins of an IC socket are thought to be shorted because of the closeness of such pins.

If you want to test a completed printed circuit (not made by yourself), it is recommended to set the output voltage to 0.4...0.5 V_{pp}. The generator in figure 1 should then be supplemented by voltage divider R3/R4 as shown. ◾

Literature: *inCider*, October 1983



For some computer applications it is very convenient to have a one-line display with small dimensions and low current consumption instead of a complete monitor. A good example of this is the microprocessor-controlled frequency counter published in last January's issue. The sort of display and associated control electronics used there is also suitable for other mini-computer systems or circuits using a microprocessor so it is considered here as a separate unit.

alphanumeric display

one complete line controlled by a single IC

Dedicated ICs can greatly simplify many applications in electronics. This is certainly true of the display module shown here. It consists mainly of an alphanumeric vacuum fluorescent display and a display controller IC. Numbers, letters and other characters (the whole ASCII character set, in fact,) can be displayed. The text can also be made to move along the display.

The special printed circuit board developed for the display module has already been shown in the frequency counter article. A number of LEDs and switch connection points are included on the board even though they do not actually belong with the display. They do, however, make the unit more versatile and easier to tailor to other purposes. The layout of the board is universal so it can easily be used with other electronic circuits driven by a microprocessor. This latter point — that a microprocessor is used for control — is essential as the information must be sent to the display in a particular sequence.

The circuit

There is very little to be seen in the circuit diagram of figure 1. The fluorescent display is accompanied by one IC and a few discrete components. Understandably, the IC is somewhat special so we will have a closer look at that to make the circuit easier to understand.

The Rockwell 10937 is a controller IC for 14 or 16 digit multiplexed displays. Up to 16 digits and the associated decimal points and commas can be controlled at the same time. The display outputs can supply a maximum of 10 mA. All the timing for the display is handled by the IC itself so the processor system only has to provide the data for display and some control information.

The main parts of the IC are shown by the block diagram of figure 2. Data for display is loaded into the display data buffer via the serial data input. The timing and control block synchronizes the segment and digit output signals to ensure that the multiplexing is correct. The segment decoder contains the complete ASCII character set in a 16 x 64 bit PLA (programmable logic array). Two further blocks contain the segment and digit drivers.

Returning to the circuit diagram (figure 1) we see that the display's segments and digits are connected directly to the driver outputs of the IC. Each of the drivers is fitted with a pull-down resistor (R10. . . R41). Most of the remaining components are needed to power the unit. The V_{SS} con-

1

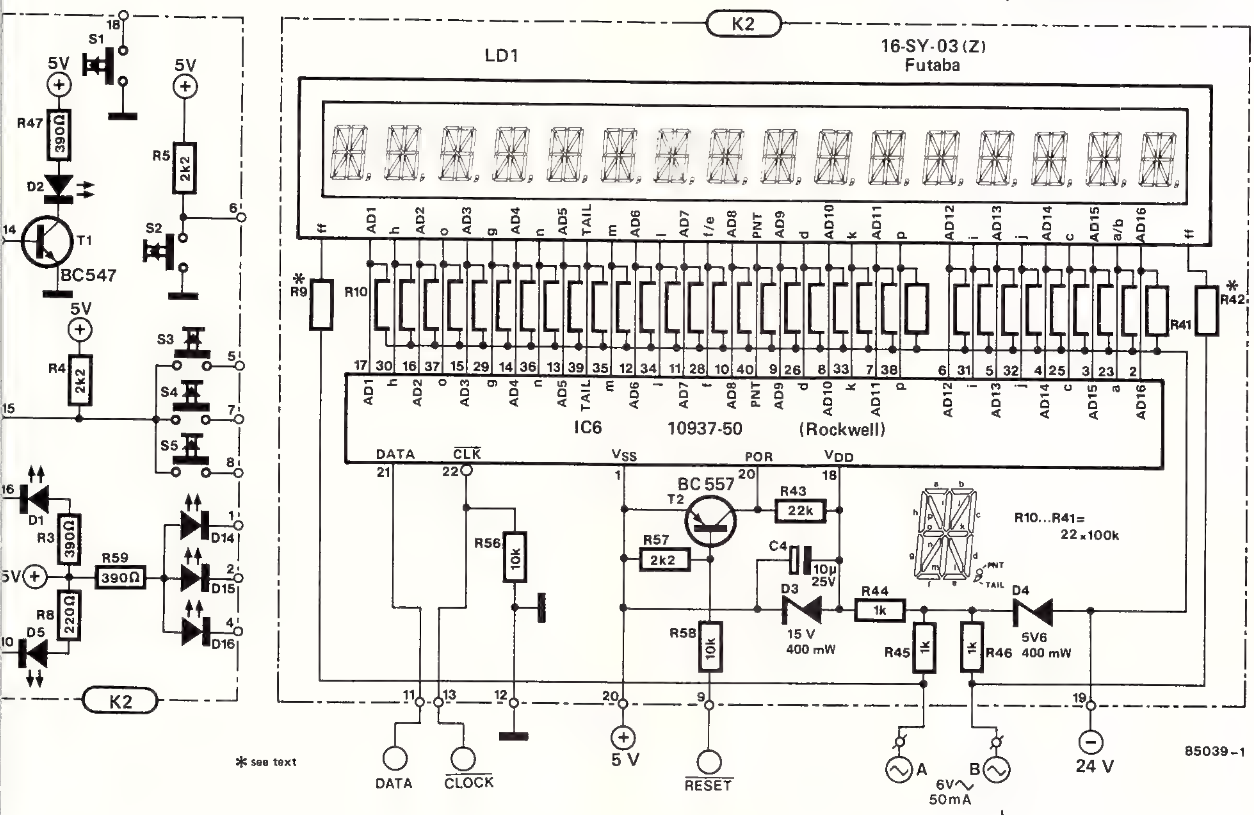


Figure 1. This circuit diagram shows that the module contains only two major components: a 16-digit vacuum fluorescent display and a special controller IC.

ection should be linked to the processor ystem's +5 V line. A —10 V supply feeds he V_{DD} connection via D3 and C4. The ilament voltage for the fluorescent display s presented to points A and B. With the ype of display indicated here this must e 5.8 V. A pair of resistors, R9 and R42, re used to reduce the transformer oltage to the right level. The value of the esistors is calculated by first connecting a 30 Ω resistor across the transformer and easuring the a.c. voltage across the load. ach of the resistors must then be given a alue of [(57U-330)/2] Ω, where U is the oltage measured.

he filament, which also acts as cathode, s fed a voltage of 5.6 V above the —24 V .c. via resistors R45 and R46 and zener iode D4. This ensures that inactive egments of the display are actually urned completely off. The V_{SS} connection is the signal 'ground' line for the ystem. None of the power supply lines ay be connected to the computer ystem's ground line. There is, of course, a round connection on the printed circuit oard but that is only for extras such as EDs. In spite of the signal ground being t 5 V a '0' is still < 0.8 V and '1' is > 3.8 V ith respect to the computer ground.

he display can be reset by a negative ulse via R57, R58 and T2. This could also e a manual reset if a push-button is connected between R58 and the computer's round line.

he circuit diagram includes some spare' switch connections, resistors and EDs. These are free for each user's own urposes.

2

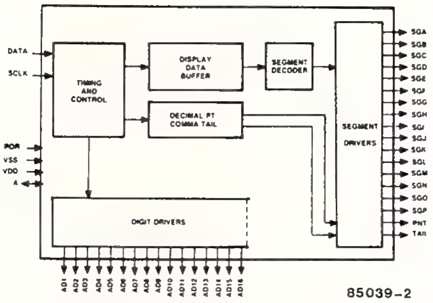


Figure 2. The 10937 controls all the functions of the display. Here we see what it is made up of.

The data format

The input data for the 10937 consists of a series of 8-bit data words. The first bit that is transmitted (b7) decides whether the IC must consider the present byte as control information or an ASCII character for the display. A '1' indicates control information and '0' represents display data.

There are three control codes:

- load the display data buffer pointer
- load the digit counter
- load the duty cycle register.

The layout of the control bytes is shown in table 1.

Load Buffer Pointer is used to move the display data buffer pointer to the desired character position so that the next character transmitted is placed in this position. To indicate the position the decimal position of the digit minus 2 is loaded into

Table 1.

control word	code
LOAD BUFFER PTR (position of the character to be changed)	1010XXXX
LOAD DIGIT CNTR (number of digit position)	1100YYYY
LOAD DUTY CYCLE (on/off, brightness, timing)	111ZZZZZ ↑ control bit

XXXX gives the position of the character (4 bit word)
YYYY gives the number of digit positions (4 bit word)
ZZZZZ gives the number of clock periods for which a specific digit is on (5 bit word)

Table 1. This is how the control word is built up.

Table 2.

Display-Data	ASCII-Character	Display-Data	ASCII-Character
01000000	@	00100000	
01000001	A	00100001	!
01000010	B	00100010	"
01000011	C	00100011	#
01000100	D	00100100	$
01000101	E	00100101	%
01000110	F	00100110	&
01000111	G	00100111	'
01001000	H	00101000	(
01001001	I	00101001	)
01001010	J	00101010	*
01001011	K	00101011	+
01001100	L	00101100	,
01001101	M	00101101	—
01001110	N	00101110	.
01001111	O	00101111	/
01010000	P	00110000	0
01010001	Q	00110001	1
01010010	R	00110010	2
01010011	S	00110011	3
01010100	T	00110100	4
01010101	U	00110101	5
01010110	V	00110110	6
01010111	W	00110111	7
01011000	X	00111000	8
01011001	Y	00111001	9
01011010	Z	00111010	:
01011011	[	00111011	;
01011100	\	00111100	<
01011101	]	00111101	=
01011110	∧	00111110	>
01011111	—	00111111	?
↑ Control-Bit		↑ Control-Bit	

Table 2. These are all the ASCII characters that are available from the 10937.

3

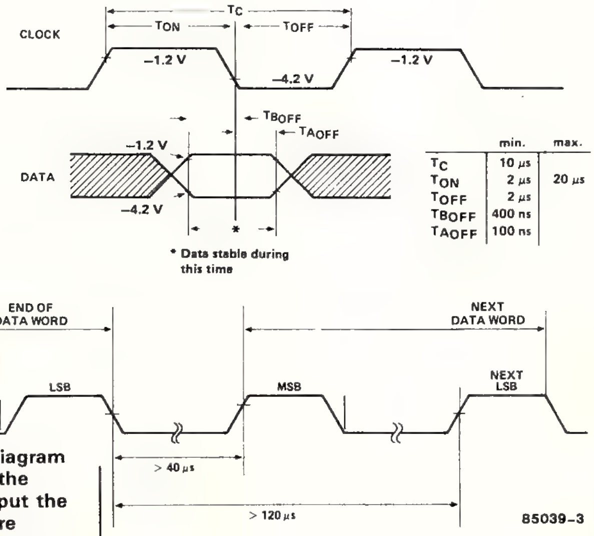


Figure 3. In this diagram of the timing for the clock and data input the voltages shown are measured with reference to the +5 V line.

this byte. The left-most display in the diagram is number 1. Below 0 the count continues downwards from 16 so digit 1 has a decimal value of 15 and digit 2 a value of 0.

The Load Digit Counter code is normally used in initialising to indicate the number of digits used. The multiplexer frequency is then modified to suit the number of active digits. For 16 digits the code used is 0.

Load Duty Cycle determines for how long the display is switched on and off and in this way the brightness can be set. Each digit has 32 clock periods available and can be switched on for a maximum of 31 of these. They must be off for at least one clock cycle out of every 32.

After a reset pulse (which is always a consequence of switching on the supply voltage) the following occurs:

- the digit and segment drivers are all switched off
- the Load Duty Cycle 'on' time is set to 0
- the Digit Counter is set to 16 (bit code 0)
- the Load Buffer Pointer is set to 15 (= digit 1).

After this the desired control information must first be provided. The order is not important:

Load Duty Cycle
Load Digit Counter
Load Buffer Pointer

Then come the ASCII codes. The buffer pointer is automatically incremented after each data word, except in the case of decimal points and commas. After digit 16 the pointer jumps to digit 1. If the digit counter is programmed so that not all the digits are used the duty cycle must be carefully chosen. If the number of digits used is 8, for example, the duty cycle must not be higher than 16, with 4 digits it is 8, and so on. If this is not done there is a danger of the display burning out.

There are a number of points to bear in mind when programming the processor. The clock and data line must be reset to zero immediately after switch-on or the circuit will act strangely. Timing also requires a certain amount of care. There must be at least 40 µs between the end of one data word and the start of the next. There must also be at least 120 µs between the start of one data word and the start of the next one (this is shown in figure 3).

The display module has certain power requirements. It needs +5 V (supplied by the computer system), —24 V d.c. (with respect to the processor system's ground line) and an a.c. supply of 6 V.

The information in this article should be sufficient for you to write a program to show the desired characters on the display. Further information on the theory and background of the actual display can be found in the applicator on page 6-58 of the June 1983 issue of Elektor. ◼

Literature:

Rockwell datasheet — 10937 alphanumeric display controller.
Elektor June 1983 — applicator, page 6-58.

While here on earth we discuss, seemingly *ad infinitum*, the pros and cons of alternative energy sources, there is not far from us — a mere 90.5 million miles (149.5 million kilometres) — a nuclear plant that has been going for the best part of 5000 million years and is estimated to go on for another 10 000 million years. The amount of energy this factory releases through nuclear fusion each second (it converts 600 million tons of hydrogen into helium at a temperature of 15 million degrees Celsius every second) is enough to meet our earthly needs for energy for a million years. That factory is, of course, our sun.

solar battery

the answer to our energy problems?

Although we know that the sun radiates all that energy into space — only an infinitesimally small part of it is absorbed by the earth and other planets in our solar system — we do not really know how to harness it on a large scale. How can we convert the solar energy falling onto earth into electric energy for powering our industries, transport, heating and lighting systems, and others?

Heat and electricity

Who has not tried to set fire to a piece of paper with a magnifying glass? This is one of the oldest methods of converting solar energy. Archimedes used it successfully — with the aid of a parabolic mirror — in the defence of Syracuse.

In a parabolic mirror, the energy falling onto a large area is optically concentrated n one point, called the focus. This leads o very high temperatures at the focus, which may, for instance, heat the water in he boiler of a steam engine that is used o drive an electric generator.

A second method of gaining heat from solar energy has come about in the last decade: large solar collectors placed in south-facing roofs of buildings. In these, here is no focusing of energy; instead, water flows through the longest possible path just under the surface of such collectors and is heated direct. This method is based on the principle of the heat exchanger.

A third method of using solar energy lies in the direct conversion of solar energy into electric current, and it is with this method that the present article is concerned. However, do not think that it will be possible to make use of a large part of the radiation released by the converting of hydrogen to helium at the core of the sun, as some simple arithmetic shows. The sun radiates equally in all directions. As the average distance from sun to earth is about 150 million kilometres, the (electromagnetic) radiation takes about 8 minutes to reach the earth. In those eight minutes, the total energy radiated by the sun has spread over the inside of a sphere of surface area 3×10^{17} km². The total surface area of the earth that is being lit by the sun at any one time amounts to only 113×10^{6} km². Even if we were able to cover that whole area with solar cells, we would receive only 3 tenthousandmillionth parts of the totally radiated energy. The rest (virtually all) is lost in the universe. However, the situation is not as hopeless as at first sight it may look, because only

1

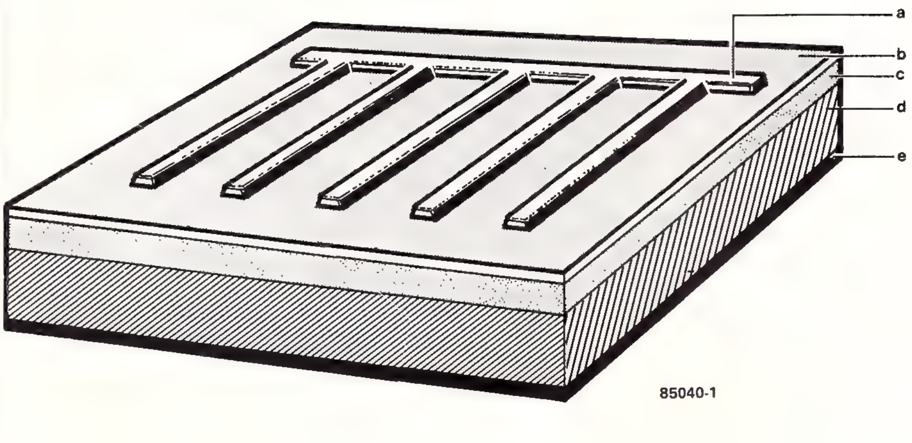


Figure 1. Schematic representation of a solar cell; note that the thickness of the front ohmic contact has been drawn highly exaggerated in comparison with the other dimensions.

a = front ohmic contact ⊕
b = anti-reflect layer
c = }
d = } p-n juntion (Si)
e = contact plate (-)

2

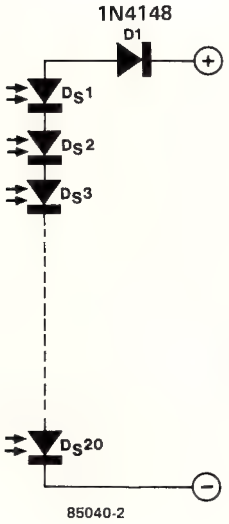


Figure 2. Circuit of the solar battery charger, consisting of twenty solar cells in series.

19 000 km^2 of solar cells would receive enough energy to meet the estimated world demand for the year 2000.

Construction and operation of a solar cell

After the astronomical figures of the last section, we return to earth and the microscopic dimension of the cross section of a solar cell. The thickness of the cell shown schematically in figure 1 has been highly exaggerated in comparison with the surface dimensions.

A solar cell uses the photovoltaic effect to convert radiation from the sun into electrical energy. The photovoltaic effect arises when a junction between a metal and a semiconductor or two opposite polarity semiconductors is exposed to electromagnetic radiation, usually in the range near-ultraviolet to infra-red. A forward voltage appears across the illuminated junction and power can be delivered from it to an external circuit.

The p-n junction of which the cell consists has a relatively large surface area and relatively high efficiency (10. . .15 per cent). Solar cells are fabricated mainly from silicon, gallium arsenide, selenium-cadmium sulphide, and thin-film cadmium sulphide. As part of the radiation is reflected by the surface of the cell, an anti-reflect layer is incorporated to minimize reflection. The absorption coefficient is large for short wavelengths, and smaller for longer wavelengths.

The efficiency of solar cells reduces by about one half per cent for each degree centigrade rise in their body temperature, so that most cells must be suitably cooled. Note, however, that this depends to a large extent on the material; gallium arsenide/gallium phosphide, for instance, has optimum efficiency at well over 100°C. The spectral response curve of a silicon cell indicates a useful range of wavelengths between 0.5 μm and 1.0 μm, peaking at about 800 μm.

Angle of incidence and atmospheric absorption

Placing the cells at right angles to the sun ensures that the highest possible amount of radiation falls onto the cell surface. It should, however, be noted that at our latitudes it is never possible to equal the amount of radiation that can be received in regions between the tropics of Cancer and Capricorn. The reason for this is that the distance the radiation travels through the atmosphere is shorter in these regions than at more northerly or southerly latitudes.

Solar battery charger

The circuit of a solar battery charger, designed and tested by us, is shown in figure 2. It consists of twenty single solar cells connected in series. In the calculation of the required charging voltage, allowance must be made for the 0.6 V drop across diode D1. This diode is necessary to prevent the electrical battery discharging through the solar cells.

Specifications and technical data supplied by the manufacturers of solar cells must be treated with caution as they normally refer to optimum incidence of radiation, which, owing to climatological and

3

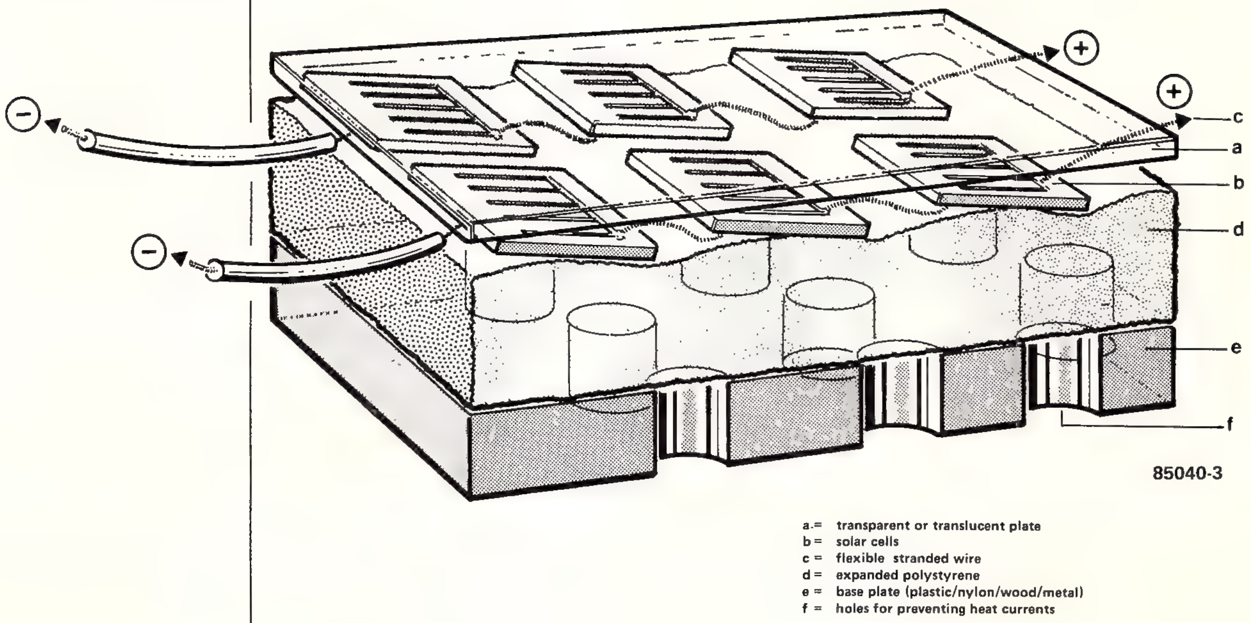

+
+
c
a
b
d
e
f
−
−
85040-3
a = transparent or translucent plate
b = solar cells
c = flexible stranded wire
d = expanded polystyrene
e = base plate (plastic/nylon/wood/metal)
f = holes for preventing heat currents

Figure 3. Construction of the solar battery charger showing how each cell is connected to the next by a short length of flexible stranded wire.

geographical factors, cannot always be realized. It is true that even under moderate light conditions the no-load voltage of a cell is about 0.5 V. However, the current produced by the cell is a function of the incident light radiation: this is shown schematically in figure 5 where the voltage/current characteristic of a cell moves further and further to the right with ncreasing radiation.

The characteristic in figure 4 shows the voltage/current relation of our solar battery charger. Measurements for this curve were taken on a sunny November day, in mid afternoon, at a latitude of about 51°N. Note that the maximum current is just about 20 mA, which is sufficient to charge a small electric battery. Increasing the oad caused a voltage breakdown. It is clear that the optimum operating point is at the knee of the curve.

Construction of the solar battery

The fragile solar cells are connected ogether with thin, **flexible** stranded wire. Solder one end of the short length of wire o the front ohmic contact (positive terminal) of one cell and the other end to the nderside (contact plate) of the next cell s shown in figure 3. Where the solar battery is placed in the open, it is advisable o protect it from the environment by, for nstance, housing it in a transparent or ranslucent case.

Economics of solar cells

Although solar cells provide a promising lternative source of energy, the time is ot yet ripe for terminating your contract with the Electricity Board. This is because for the generation of one kilowatt of power a solar battery with a surface area of 10 m² is required. As prices are still around 50p per square centimetre, that one kilowatt of power would be very expensive indeed — certainly compared with the few pence charged by the Electricity Board. None the less, solar cells have become, and will remain, the most important long-duration power supply for satellites and space vehicles.

4

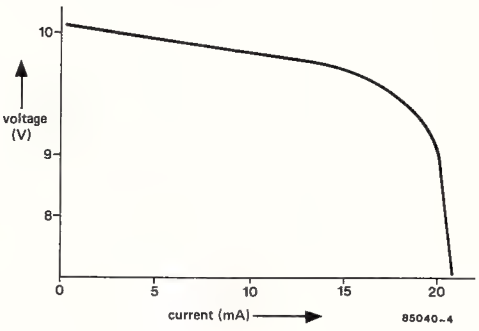


Figure 4. Voltage vs current characteristic of the solar battery charger based on measurements on a sunny November afternoon at latitude 51° north.

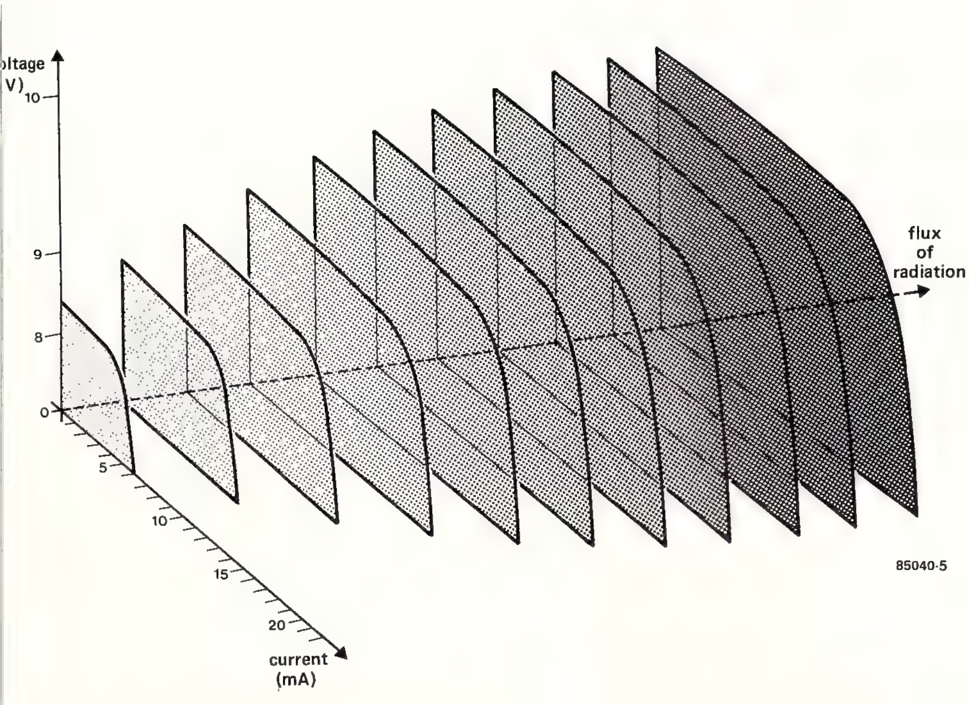
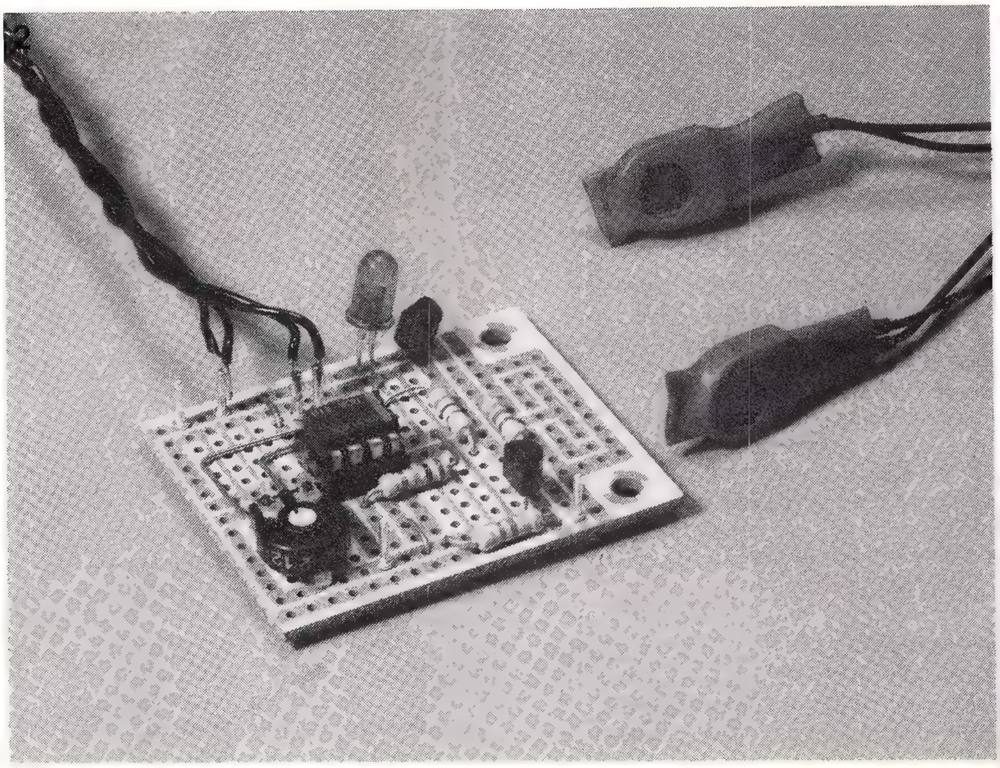


Figure 5. The voltage vs current characteristic of a solar cell is largely dependent on the incident flux of radiation. The larger the flux, the larger the current and, to a much lesser extent, the voltage.



2

This photograph shows our prototype of the 'computer eye' and, in the background, the LDRs fitted in shrink sleeves.

To put your mind at rest: the title does not imply that the circuit described here enables a computer to see. But if you want to use your computer for controlling external equipment without connecting this direct to the computer, the proposed circuit will 'keep an eye' on certain output signals of the computer and on that basis switch the equipment on and off. In other words, it provides an optical coupling between the computer and the equipment to be controlled. This does imply, of course, that a monitor screen is available and that the computer has some graphics facilities. Otherwise there would not be much to see for the eye!

computer eye

control by monitor screen

The circuit is based on an opto-electronic comparator as shown in figure 1. The 'eye' proper is formed by two light-dependent resistors — LDRs — R1 and R2. The voltage level at their junction is applied to the inverting input of the comparator, IC1, via R4. The non-inverting input of IC1 is held at a fixed reference voltage. The comparator toggles when the level at its pin 2 is lower than the reference voltage. Transistor T1 is then on, and the relay is actuated. At the same time, T2 conducts, so that the LED, D1, lights to indicate the state of the circuit visually.

When the level at the inverting input of the comparator is higher than the reference voltage, the relay is not energized, and D1 is out.

The idea is that the control program includes instructions which cause two light areas to appear on the monitor screen as required. The intensity of one of these areas should be constant, while that of the second should be either low or high (dark or light). The preferred mode of operation is for the second area to be dark when the external equipment should be switched on, and bright when it is to be switched off.

The LDRs should be attached to the monitor screen where the two light areas appear. The voltage (about 2 V_{pp}) at the junction of these resistors is a measure of the difference in brightness between the two light areas on the screen. Superimposed on this voltage is, of course, the sawtooth voltage produced by the 50 Hz line scan oscillator. Resistor R4 and capacitor C1, and to some extent P1, ensure that this sawtooth voltage does not

1

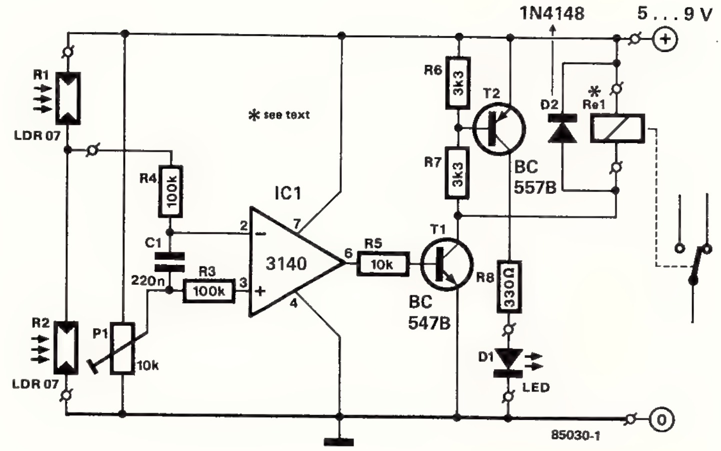


Figure 1. If you do not want to connect all kinds of equipment to your computer, you can still operate that equipment with this 'computer eye': an optocoupler which is nothing but a light-dependent comparator.

ffect the correct operation of the com-
arator.
onstruction of the circuit is not critical:
ll components, except the LDRs, are fit-
ed on a small prototyping board. The
DRs are connected to this board by suffi-
iently long pieces of stranded equipment
ire. It is recommended to fit them in
uitable shrink sleeves or swathe them in
nsulating tape in such a way that only the
ght of the two areas on the screen falls
nto them (see photograph). They can be
ttached to the screen with some self-
dhesive tape. If the equipment to be con-
olled is switched on when it should be
witched off, and vice versa, simply inter-
hange the LDRs.
resetting of the comparator is not critical
s long as the change-over frequency of
e two light areas is of the order of 1 Hz.
that case, P1 is simply set so that the
elay is actuated and de-energized in
hythm with the change-over frequency.
hen that frequency is higher, e.g. when
e circuit is used for data transfer, the
resetting of P1 becomes more critical.
he maximum allowable change-over fre-
uency depends on the cut-off frequency
f the low-pass filter, R4/C1, which here is
ss than 10 Hz. Optimum setting of P1 is
en best achieved by applying a square-
ave voltage at a frequency of about 8 Hz
the comparator input. Measure the out-
ut at pin 6 with an analogue voltmeter
0 V d.c. range) and adjust P1 so that this
vel is half the value of the supply
oltage. Although the pointer of the
oltmeter quivers somewhat, the setting
an be carried out without any trouble. If
ou have an oscilloscope, it is, of course,
referable to use that for the presetting.
ote that the current through the relay
oil should not be too high: when a
C 547 is used for T1, it should not exceed 100 mA. That means that the resistance of the coil should be not less than 50 Ω for a supply voltage of 5 V, and not less than 90 Ω at 9 V. The rating of the relay contacts depends on the equipment to be controlled.

Current consumption of the circuit amounts to only a few mA plus the current drawn by the relay coil. For data transfer operation only, the relay is not required: the signals are then taken direct from the collector of T1. ◀

Did you know...?

Robot has come to mean an intelligent and obedient but impersonal machine; it is derived from the Czech *robota* — forced labour. The word robot was first used in Karel Čapek's play *Rossum's Universal Robots* (1920).
(OED)

Gain is a ratio, normally expressed in dB. For an amplifier it is the ratio of output power to input power; for an aerial, it is the ratio of the voltage produced by a signal entering along the path of greatest sensitivity to that produced by the same signal entering an omnidirectional aerial. Although often used as such, it is not synonymous with amplification, which is a number indicating by how many times an electronic device increases an electrical signal. Gain is, therefore, 10 or 20 times the logarithm of the amplification, depending on whether that refers to a power or a voltage increase. ◀

market

New books and catalogues

Oscilloscope probes and BNC cable assemblies

A colour leaflet is available from Black Star with technical specifications of a new range of British made passive probes and BNC cable assemblies.

The passive probes feature a new compact body style, bandwidth up to 300 MHz, and a detachable earth lead.

BNC cable assemblies are available in varying lengths up to 2 m, and are terminated into BNC plugs, 4 mm plugs, or crocodile clips.

Black Star Limited
4 Stephenson Road
St Ives
Huntingdon
Cambs PE17 4WJ
Telephone: (0480) 62440
Telex: 32339

Power semiconductors data book

International Rectifier's 1985 product guide and specification data book for power semiconductors is now available, with new information reflecting IR's successful quality and reliability programmes.

The new data book is prefaced with a master JEDEC/alpha-numeric index. Special sections include standard/custom assemblies, a brief listing of HEXFET$^{\text{TM}}$ power MOSFETs by package type and a product digest of IR's solid-state relays, microprocessor input/output modules, and advanced products.

The power semiconductor guide provides complete data and specifications on thyristors up to 125 A; rectifiers up to 300 A; Schottkys up to 200 A; and includes add-a-pak thyristor/diode modules; moulded power products; pace-pak thyristor/diode bridges; and power Schottky centre-tap modules; plus the complete range of diode bridges up to 200 A; semiconductor fuses up to 800 A; and military qualified products.

International Rectifier
Hurst Green
Oxted
Surrey RH8 9BB
Telephone: (088 33) 3215/4231
Telex: 95219 (rectuk g)

A science teacher's companion to the BBC microcomputer

by Philip Hawthorne
ISBN 0 333 38285 4 Pbk
Price £9.50

Published by Higher and Further Education Division
MacMillan Publishers Limited
Houndmills
Basingstoke
Hampshire RG21 2XS
Telephone: (0256) 29242

As the title says, this book is intended primarily for teachers, more particularly those teaching the natural sciences, but is also of great use where a BBC microcomputer is employed as a teaching aid in other disciplines. It is possible, with the aid of this book, to set out a complete course of practical work based on the BBC micro.

The work explains clearly how to use the BBC micro to write programs, particularly in the fields of simulation, control, interfacing, and data acquisition. All this is not treated in a dry, theoretical manner, but rather in practical application. For instance, how to represent the transmission of radio waves is tackled by first showing how animation is effected on the BBC micro, i.e., how moving images are created, and subsequently dealing with the technique of radio transmission in an easy to understand manner. Throughout the book the aim is to work from posing the problem to solving it in a comprehensive and comprehensible manner, which means that pupils are learning all along.

Another example is how to write your own program in the interrupt routine of the BBC micro, is dealt with down to every detail. First, there is a description of the source of the interrupt, the VIA (versatile interface adapter), after which the vectors of the service routine, and how these are used, are explained.

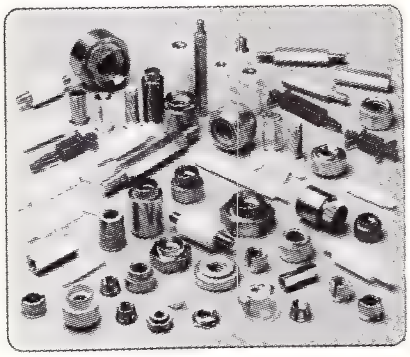
One of the chapters shows how a simple robot, complete with constructional details, can be connected to the user port and controlled.

In total, the book contains some sixty useful programs, and this convinced us even more than all the other good points that this book is worthy of serious study by all BBC micro users, and not just teachers.

Captive fasteners

A comprehensive 44-page brochure published by PSM Fasteners Ltd covers their extensive range of captive fasteners for thin sheet metal, electronic assemblies, and printed circuit boards.

The main section of the brochure deals with nine fastener types and the many variants.



Each product is fully described, with detailed information on fastener characteristics and methods of installation, together with data on thread sizes, dimensions, and recommended hole sizes for ease of specification.

Threaded fasteners for thin sheet metal include rivet bushes, self clinching and self piercing fasteners, blind fitting captive nuts, and push in blind fitting fasteners.

Fasteners for electronic assemblies and PCBs include nylon support posts and self broaching fasteners for PCBs and threaded spacers and support pillars to provide a convenient means of spacing panels and other components with standard nuts and machine screws.

PSM Fasteners Ltd
Longacres
Willenhall
West Midlands WV13 2JS
Telephone: (0902) 66081
Telex: 338568

Elesta PCB relays

This brochure lists a wide range of relays intended for use on printed circuit boards. Most of the relays are available for operation from 6, 12, 24, 48, 60, or 110 V DC.

Britec Limited
Unit 17
Bermondsey Industrial Estate
Rotherhite New Road
London SE16 3L
Telephone: (01) 237 8081/4
Telex: 896161

Instruments catalogue 1985

As one has come to expect from Marconi Instruments, their catalogue for 1985 is second to none. This nicely bound book not only gives detailed information on a whole range of measuring and test instruments from signal generators to digital communications test equipment, but also hints on use, NATO reference numbers, other publications, and sales offices world-wide.

Marconi Instruments Limited
Longacres
St Albans
Herts AL4 0JN
Telephone: (0727) 59292
Telex: 23350 (3249 M)

Matthey video filter catalogue

Matthey have miniaturized their wide range of video filters and improved the performance at the same time. The new catalogue (free on request) lists the whole range together with useful information such as K-rating data for PAL and NTSC systems, and cut off slope ratios to ease the customer's selection process. In addition, new filters designed for Teletext signal processing are described. A paper on Teletext filters is also available.

Data on other filters for the TV broadcasting industry, digital signal processing, image enhancement, and satellite TV complete the catalogue.

Matthey Electronics
Burslem
Stoke on Trent ST6 3AT
Telephone: (0782) 85631
Telex: 36341 (mppbur g)

Farnell Electronic Components Catalogue

This is a magnificent catalogue: in almost 700 pages you will find a host of items catering for every aspect of electronics, from books, components, tools, and electrochemicals to computer products and system support. Farnell emphasize that every item in the catalogue is carried in their stock, subject only to being generally available from the manufacturer concerned.

Farnell Electronic Components Ltd
Canal Road
Leeds LS12 2TU
Sales desk: (0532) 636311
Technical Enquiries: (0532) 799123
Telex: 55147

New cyanoacrylate adhesives from 3M

The three new ScotchWeld cyanoacrylates are one part, high bond, extremely fast setting adhesives that cure quickly at room temperature.

Adhesive type M2000 is specially developed to bond small areas of metals, such as aluminium, steel, and brass, either to itself or to other materials. It is particularly useful for bonding rough or uneven surfaces where some degree of gap filling is required, and can be used on vertical surfaces.

The type E1100 is a very fast setting, high viscosity product to bond plastics and rubber, that will also provide good adhesion to metals. It can be applied through autometic metering equipment without the normal stringing problems of medium or high viscosity cyanoacrylates. E1100 will bond porous materials, such as wood, cork, and leather with good weathering resistance.

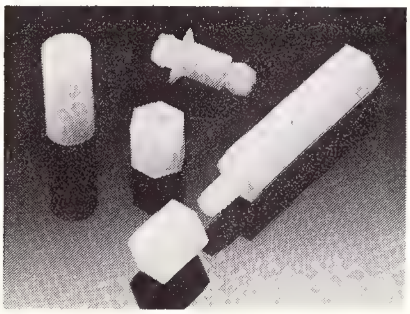
The type B20 is a low viscosity adhesive particularly suitable for bonding profiles of solid and foam rubber. It will also bond synthetic elastomers such as FCPDM™, Fluorel™, and Viton™ in blunt or mitre cuts which cannot normally be bonded with cyanoacrylates.

3M United Kingdom PLC
3M House
P O Box 1
Bracknell
Berks RG12 1JU
Telephone: (0344) 426726 (3257 P)

Nylon spacers and stand-offs

The newly formed Electronic Connector Division of Midland-Ross Ltd have announced a new line of non-metallic spacers and stand-offs for electrically isolating a circuit or spacing any number of PCBs.

The new hardware includes round through hole spacers, self-threading hexagonal spacers, male and female threaded and tapped stand-offs, all 6 mm to 25 mm long, and a line of push-in locking spacers that are self fastening and require no further mounting hardware.



Midland-Ross Limited
Electronic Connector Division
Cambion, Hollingsworth
Dukesbridge Chambers
1 Duke Street
Reading
Berks RG1 4LN
Telephone: (0734) 500051/2
Telex: 849992 (3253 P)

Abacus now offer Piher capacitors

Abacus Electronics, among the leaders in component distribution in the UK, can now supply two capacitor ranges from Piher — electrolytic and ceramic plate types.

The Piher range of miniature electrolytics, competitively priced components for general purpose miniature applications, which includes both axial and radial types, is available for immediate delivery ex-stock.

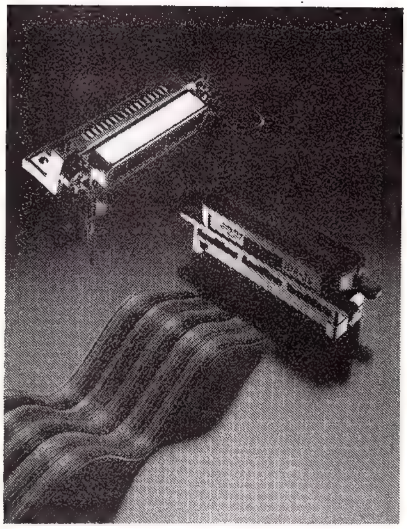
The Piher range of ceramic plate capacitors is aimed at the low-cost, single-layer market, and is available in many standard values. These devices are available in 63 V and 100 V versions and can be supplied pre-formed for either 2.5 mm or 5 mm PCB pitch.

Abacus Electronics PLC
Abacus House
Bone Lane
Newbury
Berks RG14 5SF
Telephone: (0635) 33311
Telex: 847589 (3255 M)

Ribbon D connectors for PCB or cable

Designed for use as a system interface, the new IDR and RPM Series of ribbon D connectors from Dage are available for flat cable termination or permanent PC mount. The connectors are standard 36-way types, and are constructed for industry-wide compatibility with all standard ribbon connectors.

The connectors are available in two basic configurations. The IDR Series terminates to 28 AWG standed flat cable and incorporates body features for bail latching mechanisms. The RPM Series is available for straight or right-angle PC mount and is designed for permanent solder applications.



Dage (GB) Limited
Eurosem Division
Rabans Lane
Aylesbury
Bucks HP19 3RG
Telephone: (0296) 33200
Telex: 83518 (3256 P)

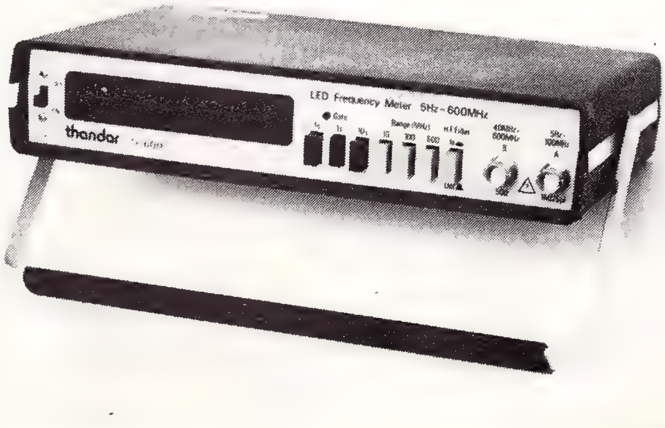
New frequency meter

The TF600 frequency meter available from Thandar is a battery or mains (via a.c. adapter) operated unit with a large half-inch eight-digit LED display. The frequency range is 5 Hz. . .600 MHz with a sensitivity of better than $10\ \mathrm{mV_{rms}}$ over the entire range.

There are two inputs: input A is a high-impedance (1 M) input for the 10 MHz and 100 MHz ranges (a low-pass filter — 40 kHz — is provided); input B is a 50 nominal input for the 40 MHz. . .600 MHz range.

The display reads out direct in kHz and also has indicators for overflow, gate, and low battery. The decimal point is positioned automatically on all ranges.

Thandar Electronics Ltd
London Road
St. Ives
Huntingdon
Cambridgeshire PE17 4HJ
(0480) 64646 (3142 M)



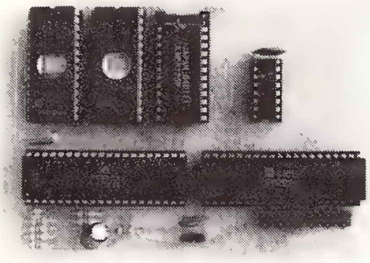
High isolation power relay

ITT Switches (UK) Limited, the largest supplier of switches and relays in Europe, has added the HZ2 to its well-proven HZ1 miniature power switching relay. The HZ1, provides a single pole function of normally open or change-over configuration, switching up to 16 A and 10 A respectively. The new HZ2 is a two pole version with the same contact options and both sections capable of switching up to 5 A.
Both relays are suitable for printed circuit board mounting and available in a flux-tight or a wash-tight housing.

ITT Switches (UK) Limited
The Mill House
Barry Avenue
Windsor SL4 1QS
Telephone: (0753) 840141 (3234 M)

Control 89

This compact 82×110 mm microcontroller offers the user an opportunity to gain familiarity with the type 6809 eight-bit microprocessor, which has over 1400 instructions and a complete set of addressing modes.
The basic system offers 2 Kbytes of static RAM, up to 32 K of EPROM decoding, a 6522 VIA that provides sixteen I/O lines and handshakes lines, two powerful sixteen-bit interval counters, and an eight-bit shift register.

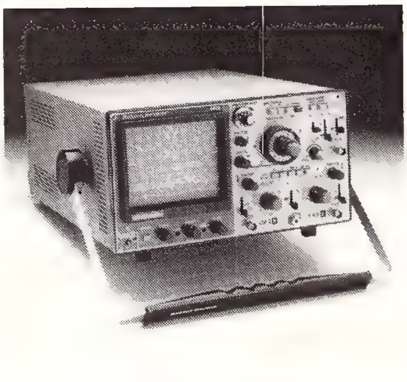


The VIA interrupts are serviced for fast response, making the card ideally suited to small control applications and use as an educational aid.
The card requires a +5 V supply and comes fully tested with user notes and circuit diagram at £64.95 + VAT.

J P Designs
37 Oyster Row
Cambridge CB5 8LJ
Telephone: (0223) 322234 (3254 P)

Beckman moves into oscilloscope market

Beckman Industrial has extended its Circuitmate range of low-cost test instruments with the introduction of two professional grade oscilloscopes — models 9060 and 9100. Both models offer three-channel vertical inputs, eight traces, and a dual time base with delayed sweep. They are small enough (340 mm wide × 190 mm high × 450 mm deep) to fit on crowded work benches, and light enough (7 kg) for field applications. The price of the 9060 is £1095, and that of the 9100 is £1495.
Innovations for this type of oscilloscope include:

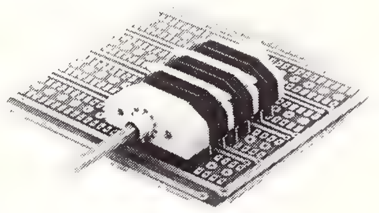


linear focus control which ensures that the trace is focussed regardless of intensity;
trigger level lock control which makes adjustment of the trigger level automatic over a wide range of signals;
dynamic bias circuitry, which reduces power consumption by minimizing power requirements during idle periods or when low frequency signals are being displayed.
A rear panel output for channel 1 permits the user to monitor this channel with a counter or other device, eliminating the need to connect another test function.

Beckman Industrial Limited
Electronic Technologies Division
Sales & Marketing Organization
Mylen House
11 Wagon Lane
Sheldon
Birmingham B26 3DU
Telephone: (021) 742 7921 (3250 P)

Rotary switches for PCBs

A range of rotary switches for use on printed circuit boards, and available with between two and twelve switch positions, has been introduced by Stanler Components Ltd.
The RPS12 range is also available with from one to six wafers, and one, two, three, or six pole switching. The switches have an expected life of not less than 25 000 operations. Switching capacity is 15 VA (voltage up to 125 V AC and current up to 0.2 A AC).



Stanler Components Limited
Business Centre
Hay Lane
Braintree
Essex CM7 6ST
Telephone: (0376) 40902 (3251 P)

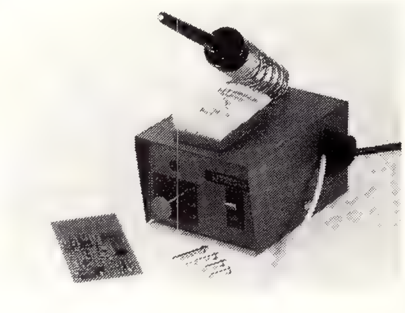
Unicom modem under £50.00

A full facility modem is now available from Unicom at £49.99 ex VAT. The machine features auto dial, auto redial, auto answer, auto band rate scan, full duplex, half duplex, bulletin board facility, number memory store, compatibility with all UK, USA and European standards, power supply, leads and manuals.
The manufacturers claim that the modem is easy to understand and use, and simply plugs in. The auto band rate facility enables the modem to scan incoming data and sets the correct band rate to receive. Unicom can also automatically answer, then upload or download data into a Micro and printer just like a telex.
V21 and 23, CCITT, Bell 103 and 202 standards are met with Termi, Communicator and other existing software. Band rates are 300/300, 1200/75, 75/1200 ensuring the modem can be used for most systems in all countries.
Prestel, Micronet, Telecom Gold, Easylink and Homelink are all held in the ROM while up to 99 telephone numbers can be stored on disk with a simple two key selection.
The modem automatically redials until connected and a remote facility enables owners to dial up their own or other micros to upload or download software.
All the software commands can be incorporated into the owner's own programs and a unique error correct protocol ensures sending, storing and receiving files and programs with no transmission errors.
The software also incorporates a bulletin board facility enabling the owner to set up his own or access all others!

Unicom Limited
20 Orange Street
London WC2H 7ED
(01 930) 1612 (3137 M)

Miniature soldering station

LITESOLD have introduced a new variable temperature miniature soldering station, type PC478/38, for use on very fine work and sensitive components, where a larger temperature controlled iron is difficult to use. Its applications include soldering/rework with surface mounted devices (SMDs), electronic watch, calculator, and instrument repairs, and fine production work.



The iron weighs a mere 7 g, while the diameter of the element shaft is only 2.4 mm.
The power unit provides a continuously variable and well-regulated DC output by which the temperature of the iron can be adjusted between about 180°C and 380°C.

Light Soldering Developments Ltd
97/99 Gloucester Road
Croydon
Surrey CR0 2DN
Telephone: (01) 689 0574
Telex: 8811945 (lsd g) (3252 P)

EAST CORNWALL COMPONENTS

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ECC82	0.65
ECC83	0.75
ECC84	0.65
ECC85	0.90
ECC88	0.95
ECF80	0.95
ECH81	0.75
ECH84	0.75
ECL82	0.75
ECL86	0.98
F80	0.65
F86	1.60
F183	0.75
F184	0.75
H90	0.94
L34	3.25
L84	0.69
L509	5.50
M87	2.55
Y86 87	0.67
Y500A	1.65
CC84	0.50
CC85	0.65
CC89	0.74
CC189	0.85
CF80	0.75
CF86	1.25
CF200	1.95
CF801	1.45
CF802	1.00
CF806	1.20
CL82	0.90
CL83	2.50
CL84	0.90
CL86	1.15
CL805 85	1.35
D500	3.75
FL200	1.35
L33	1.50
L36	1.45
L81	0.85
L82	0.75
L83	0.65
L84	0.75
L95	2.00
L504	1.20
L508	2.40
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Y88	1.80
Y500A	2.40
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CH81	0.90
CL82	1.70
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Type	Price (£)
AC127	0.30
AC128	0.30
AC128K	0.34
AC132	0.55
AC141	0.26
AC141K	0.40
AC142	0.26
AC142K	0.48
AC151	0.45
AC152	0.45
AC176	0.28
AC176K	0.46
AC187	0.42
AC187K	0.48
AC188	0.44
AC188K	0.50
ACY40	0.88
AD142	1.10
AD143	1.10
AD149	0.96
AD161	0.42
AD162	0.42
AD161	
AD162	0.98
AF106	0.48
AF114	2.10
AF115	2.10
AF116	2.10
AF117	2.10
AF118	0.85
AF121	0.62
AF124	0.48
AF125	0.48
AF126	0.48
AF127	0.48
AF139	0.68
AF178	0.68
AF239	0.68
AF279S	0.75
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BA102	0.34
BA110	0.67
BA121	0.40
BA129	0.38
BA148	0.16
BA154	0.08
BA155	0.10
BA156	0.08
BA157	0.28
BA164	0.14
BB104B	0.52
BB105B	0.30
BB105G	0.48
BB110B	0.42
BC107	0.10
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Type	Price (£)
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BC113	0.14
BC114	0.12
BC115	0.12
BC116	0.15
BC117	0.22
BC118	0.17
BC119	0.30
BC125	0.12
BC140	0.28
BC141	0.42
BC142	0.30
BC143	0.30
BC147	0.08
A or B	0.10
BC148	0.08
A or B	0.10
BC149	0.09
BC157	0.10
BC158	0.10
BC159	0.10
BC160	0.30
BC161	0.30
BC168B	0.12
BC169C	0.10
BC170	0.14
BC170B	0.12
BC171	0.10
A or B	0.08
BC172	0.08
A or B	0.12
BC177	0.20
BC178A	0.22
BC182	0.09
A, B or C	0.09
BC182L	0.09
A, B or C	0.09
BC183	0.09
A, B or C	0.10
BC183L	0.08
A, B or C	0.12
BC184L	0.10
A, B or C	0.10
BC207	0.15
BC208	0.16
BC212	0.09
A, B or C	0.10
BC212L	0.08
A, B or C	0.10
BC213	0.09
A or B	0.10
BC213L	0.10
A or B	0.10
BC237	0.11
BC238	0.12
BC239C	0.14
BC251	0.12
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BC303	0.32
BC307	0.10
BC308A	0.10
BC323	0.99
BC327	0.14
BC328	0.14
BC337	0.12
BC338	0.12
BC350	0.14
BC440	0.30
BC441	0.32
BC461	0.32
BC547	0.12
BC548	0.12
BC549	0.12
BC550	0.18
BC550C	0.18
BC557	0.12
BC558	0.12
BCX34	0.27
BCY70	0.15
BCY71	0.17
BCY72	0.18
BCZ10	1.68
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BD124P	0.80
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BD131	0.34
BD132	0.34
BD131 132	0.95
BD135	0.32
BD136	0.36
BD137	0.36
BD138	0.38
BD139	0.38
BD140	0.38
BD144	1.60
BD145	1.82
BD150A	0.51
BD159	0.65
BD160	1.65
BD165	0.45
BD175	0.60
BD182	1.00
BD183	1.10
BD184	1.20
BD201	0.72
BD202	0.87
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BD222	0.80
BD225	0.86
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BD233	0.60
BD234	0.62
BD235	0.63
BD236	0.63
BD237	0.65
BD238	0.56
BD241	0.60
BD243A	0.80

Type	Price (£)
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BD375	0.32
BD410	0.76
BD434	0.68
BD436	0.68
BD437	0.76
BD438	0.75
BD439	0.68
BD507	0.48
BD508	0.53
BD509	0.54
BD510	0.48
BD517	0.56
BD520	0.66
BD699	1.25
BD707	0.88
BDX18	2.35
BDX32	2.10
BF115	0.32
BF117	0.54
BF119	0.82
BF120	0.38
BF123	0.40
BF125	0.42
BF127	0.38
BF152	0.16
BF154	0.23
BF157	0.40
BF158	0.22
BF159	0.24
BF160	0.23
BF167	0.30
BF173	0.25
BF177	0.42
BF178	0.30
BF179	0.32
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BF181	0.35
BF182	0.32
BF183	0.32
BF184	0.32
BF185	0.32
BF194	0.08
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BF196	0.10
BF197	0.10
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BF199	0.16
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BF222	0.48
BF224	0.20
BF224J	0.16
BF240	0.20
BF241	0.20
BF244	0.26
BF244A	0.28
BF244C	0.24
BF245A	0.28
BF254	0.15
BF256	0.40
BF257	0.32

Type	Price (£)
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BF259	0.32
BF262	0.30
BF263	0.30
BF270	0.30
BF271	0.26
BF273	0.18
BF274	0.32
BF323	0.92
BF336	0.26
BF337	0.38
BF338	0.38
BF355	0.42
BF363	0.82
BF367	0.24
BF371	0.27
BF422	0.38
BF450	0.38
BF457	0.33
BF458	0.36
BF459	0.44
BFR39	0.22
BFR40	0.22
BFR41	0.22
BFR51	0.30
BFR61	0.32
BFR62	0.28
BFR88	0.34
BFR90	1.72
BFT41	0.38
BFT43	0.38
BFW10	0.79
BFW44	0.75
BFX29	0.28
BFX30	0.30
BFX80	3.56
BFX84	0.24
BFX85	0.26
BFX86	0.26
BFX87	0.26
BFX89	0.65
BFY50	0.21
BFY51	0.21
BFY52	0.21
BFY57	0.40
BFY90	0.90
BFY90S	1.34
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BR101	0.44
BR103	0.58
BRC4443	1.76
BRY39	0.38
BRY56	0.42
BRY61	0.86
BSS17	0.56
BSS27	0.92
BSX19	0.34
BSX20	0.34
BSX59	0.62
BSX76	0.29
BT100A/02	0.94

Type	Price (£)
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BT101/500	1.25
BT102/300	1.35
BT102/500	1.65
BT106	1.50
BT108	1.30
BT109	1.18
BT116	1.25
BT119	3.62
BT120	3.60
BT121	3.02
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BT151 560R	0.90
BT151/300R	1.15
BTY79/400R	2.80
BU100A	2.30
BU104	2.00
BU105	1.20
BU105/02	1.56
BU108	1.80
BU124	1.75
BU126	1.25
BU133	1.80
BU204	1.35
BU205	1.30
BU206	1.70
BU208	1.55
BU208A	1.63
BU208/02	2.05
BU326S	1.75
BU407	1.65
BU407D	1.80
BUX80	3.70
BJY20	1.75
BUY69A	2.60
BUY69B	1.98
BY101	0.48
BY118	1.10
BY122	0.68
BY126	0.12
BY127	0.10
BY133	0.16
BY135	0.25
BY164	0.44
BY179	0.66
BY182	0.87
BY184	0.40
BY187	0.72
BY189	4.75
BY198	0.44
BY199	0.47
BY206	0.24
BY207	0.24
BY210 400	0.25
BY210 600	0.26
BY210 800	0.30
BY223	1.20
BY227	0.26
BY229	0.30
BY238	0.68
BYX10	0.24

Type	Price (£)
BYX36 150	0.22
BYX36/600	0.28
BYX48/300	0.72
BYX49/300	0.47
BYX55 350	0.29
BYX55/600	0.33
BYX71/600	1.18
BYZ12	0.42
C106D	0.80
E1222	0.40
E5024	0.30
GET872	0.48
ITT44	0.04
ITT2002	0.11
ME0402	0.20
ME0404/2	0.24
MEU21	0.60
MJ400	1.25
MJ2955	0.90
MJ3000	1.98
MJE240	0.60
MJE340	0.54
MJE370	0.88
MJE520	0.48
MJE2955	0.99
MJE3055	0.70
MPSL01	0.28
OA47	0.10
OA90	0.08
OA91	0.09
OA95	0.18
OA200	0.06
OA202	0.15
OC25	2.10
OC26	1.70
OC28	1.50
OC29	2.47
OC35	1.75
OC36	1.75
OC42	0.72
OC42K	1.40
OC44	0.72
OC45	0.58
OC71	0.50
OC72	0.52
OC81	0.68
OC200	2.46
OC202	2.20
ORP12	0.85
R2008B	1.50
R2010B	1.52
SHG1 5	0.40
TAG1 100	1.40
TAG3 400	1.78
TIC44	0.40
TIC45	0.45
TIC46	0.48
TIC47	0.70
TIC106A	0.70
TIP30A	0.46
TIP31C	0.54

Type	Price (£)
TIP32	0.40
TP32C	0.60
TIP33A	0.63
TIP34A	0.72
TIP41C	0.46
TIP42A	0.52
TIP47	0.60
TIP110	0.88
TIP2955	0.60
TIP3055	0.60
TIS43	0.88
TIS88	0.40
TIS90	0.25
TIS91	0.28
ZTX108	0.12
ZTX109	0.12
ZTX212	0.28
1N4001	0.05
1N4003	0.05
1N4004	0.06
1N4006	0.07
1N4007	0.07
1N4148	0.05
1N5400	0.12
1N5402	0.15
1N5405	0.16
1N5406	0.18
1N5408	0.20
1S920	0.08
2N697	0.55
2N706A	0.33
2N2904	0.28
2N2906	0.24
2N2926G	0.10
2N3053	0.40
2N3054	0.56
2N3055	0.45
2N3702	0.10
2N3704	0.10
2N3708	0.10
2N3772	1.90
2N3773	2.70
2N3904	0.16
2N3906	0.16
2N5294	0.48
2N6107	0.71
2N6126	0.68
2SB337	1.60
2SC1172Y	2.90
2SC1173Y	0.82
2SC1302	1.40
2SC1226	0.84
2SC1279	0.50
2SC1306	0.92
2SC1307	1.40
2SC1413A	2.70
2SC1444	1.45
2SC1507	0.63
2SC1678	1.06
2SC1758	0.68
2SC1909	1.20

Type	Price (£)
2SC1923	0.30
2SC1945	2.88
2SC1953	0.74
2SC1957	0.76
2SC1969	2.88
2SC2028	0.73
2SC2029	2.10
2SC2078	1.05
2SC2091	0.73
2SC2098	2.90
2SC2122A	3.20
2SC2166	1.20
2SC2314	0.80
2SC2335	1.50
2SC2749	2.70
2SC2752	0.60
2SD234	0.64
2SD348	3.30
2SD986	0.62
2SK134	3.80
2SK135	4.60
3N126	1.90
3N211	2.52
3SK45	0.76

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10nF 500V AC	**80p**
15nF 300V AC	**30p**
22nF 300V AC	**32p**
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3065	1.75
4031P	2.88
4102	3.30
4250	3.50
4400	2.98
4422	3.07
7120	5.33
7130	5.26
7137	5.16
1380N	1.65
11303N	2.52
1151P	3.12
1307P	1.85
1310P	1.85
1312P	2.25
1327P	1.25
1330P	0.83
1349P	1.85
1350P	1.20
1351P	2.50
1352P	1.50
1357P	2.88
1358P	1.30
1496L	1.15
231B	2.10
232B	2.10
237B	2.30
555	0.35
os 555	0.88
556	0.80
A1024	5.35
A1025	8.40
S560A	2.50
S560S	1.85
S570S	1.85
S580	2.85
S590	2.82
9503P	1.10
32A	4.00
01B	5.20
17B	6.25
327Q	1.10
76003N	2.44
76013N	1.90
76023ND	2.90
76033N	2.45
76110N	1.12
76115N	2.00
76131N	1.65
76226DN	1.80
76227N	1.10

SN76530P	1.40
SN76533N	1.60
SN76650N	1.05
SN76660N	0.75
SN76666N	0.80
STK015	6.50
TA7108P	3.20
TA7120P	2.20
TA7129AP	3.65
TA7130P	1.65
TA7172	1.80
TA7193	5.50
TA7172P	1.80
TA7176	2.50
TA7202P	4.18
TA7204P	1.86
TA7205AP	1.50
TA7208P	3.27
TA7210P	6.50
TA7222P	2.12
TA7223P	3.68
TA7227P	5.60
TA7310P	1.80
TAA263	2.46
TAA310A	2.68
TAA550	0.50
TAA570	1.99
TAA611A12	3.50
TAA630S	3.90
TAA661B	1.70
TAA700	2.80
TAA840	3.38
TAD100	2.80
FM FILTER	1.20
TBA120 AS,	
S,SA,SB	1.30
Q,T,U,UQ	1.32
TBA120B	1.30
TBA231	1.45
TBA281	2.65
TBA395	1.20
TBA480Q	1.50
TBA400	2.30
TBA510	2.60
TBA510Q	2.60
TBA520/Q	1.60
TBA530/Q	1.30
TBA540/Q	1.40
TBA550/Q	1.52
TBA560C	1.70
TBA560CQ	1.60
TBA570	1.50

TBA641BX1	4.50
TBA673	2.40
TBA700	2.85
TBA750	2.80
TBA800	1.60
TBA810P	1.10
TBA810S	1.20
TBA820	1.60
TBA890	3.88
TBA920/Q	3.00
TBA950/2A	3.05
TBA970	4.05
TBA990	1.88
TCA160C	3.90
TCA270S	4.00
TCA270SA	4.02
TCA800	3.10
TCA940	1.90
TDA440	3.80
TDA1002	1.90
TDA1003A	5.50
TDA1004A	3.75
TDA1006A	2.40
TDA1035S	4.50
TDA1044	4.30
TDA1170S	3.00
TDA1190	3.50
TDA1200	2.98
TDA1270Q	3.70
TDA1327A	1.66
TDA1352A/B	1.56
TDA1412	1.20
TDA2002	2.80
TDA2020	4.60
TDA2030	2.78
TDA2140	5.90
TDA2521	4.10
TDA2523	3.50
TDA2530	2.70
TDA2540	3.80
TDA2541	3.80
TDA2560	3.50
TDA2571A	2.50
TDA2581	3.20
TDA2590	3.20
TDA2591	2.98
TDA2593	2.98
TDA2610	3.20
TDA2611A	1.94
TDA2640	2.90
TDA2680	3.40
TDA2690	3.50
TDA3950A/B	2.60
UPC554C	1.32
UPC557H	0.90
UPC566H	2.95
UPC575C2	3.20
UPC1018C	1.10
UPC1025H	2.90
UPC1032H	0.90
UPC1156H	4.20
UPC1158H	0.76
UPC1163H	0.98

UPC1181H	1.60
UPC1185H2	3.75
UPC1212C	1.30
UPC1230H	3.90
UPC1350C	4.25
UPC1367C	3.40
UPC1378H	4.40
UPC2002H	2.80

SOLDERING SECTION

XS25W Iron kit, complete with stand & plug attached	8.20
CS18W as above	8.00
Antex 15W iron	5.00
Antex 18W iron	5.00
Antex 25W iron	5.20
Antex elements	2.00
Antex bits	0.95
Antex stands	1.90
Soldersucker	4.50
Spare nozzles for Soldersucker	0.65

SERVICE AIDS

ALL SERVISOL PRODUCTS

Switch Cleaner	0.98
Circuit Freezer	1.14
Foam Cleanser	0.96
Aero Klene	0.78
Silicone Grease (Aerosol)	1.22
Antistatic Spray	0.98
Plastic Seal	1.08
Excel Polish	0.92
Fire Extinguisher 640g	2.80
Video Head Cleaner	0.88
Silicone Grease (IC1) 75g	1.50
Solda Mop (Std)	0.74
Solda Mop (L Gauge)	0.74

Additional P&P on above 30p each

0.25W Type
100R-4m7 V&H
10p each,
0/90p
0.1W Type
100R-1M V&H
7p each,
10/65p

PLUGS & SOCKETS

Metal Co-ax Plug	0.18
Plastic Co-ax Plug	0.14
Metal Line Socket	0.32
Single Junction Socket	0.80
Plastic Phono	0.10
F M Plugs	0.20
PL259 Plugs	0.38
Reducer	0.15

Fuseholders

20mm Panel Mounting	0.28
20mm Chassis Mounting	0.06
1¼" Panel Mounting	0.35
1¼" Chassis Mounting	0.12
Carline 1¼" holder	0.10

TELEPHONE SPECIAL

B T App Telephone Plug · 3m Lead	£1 25
B T App Master Socket – incl Wiring Instructions	£2.85
B T App Secondary Socket	£1.95

CHART RECORDER SPECIAL

Brand new 3 channel pen recorders complete with charts Full spec upon request once only price **£40 + £10 p&p + VAT**

NI-CAD

Universal Ni-Cad Charger charges PP3,AA,C,D
Price £6.00

RECHARGEABLE	BATTERIES
AA (HP7)	.85 ea.
	10/75p ea.
C (HP11)	1.75 ea.
	10/1.65 ea.
D (HP2)	2.05 ea.
	10/1.95 ea.
PP3	3.80 ea.
	10/3.70 ea.

I C SOCKETS

Dil to Dil		
8 pin	0.08	0.70/10
14 pin	0.10	0.95/10
16 pin	0.11	1.00/10
18 pin	0.14	1.60/10
22 pin	0.21	1.95/10
24 pin	0.25	2.25/10
28 pin	0.30	2.75/10
40 pin	0.34	3.10/10

RESISTORS – CARBON FILM 5%

¼W 1RO to 10M (E12 Range)	**2p each 15p/10. 75p/100**
⅓W 2R2 to 10M (E24 Range)	**2p each 15p/10. 75p/100**
1W 10R to 2M2 (E12 Range)	**7p each 65p/10 6.00/100**
2W 10R to 2M2 (E6 Range)	**8p each 70p/10. 6.00/100**

RESISTOR KITS – each value individually packed

¼W pack 10 each value E12 – 10R to 1M 610 pieces	5.00
¼W pack 5 each value E12 – 10R to 1M 305 pieces	3.00
½W pack 10 each value E12 – 2R2 to 2M2 730 pieces	6.00
½W pack 5 each value E12 – 2R2 to 2M2 365 pieces	3.50
1W pack 5 each value E12 – 2R2 to 1M 353 pieces	15.00
2W pack 5 each value E6 – 10R to 2M2 317 pieces	18.00

RESISTORS – WIREWOUND Generally 5%

2 5W – 0 22 to 270R – Available in preferred values	0.20
4W – 1R0 to 10K – Available in preferred values	0.21
7W – 0 47R to 22K – Available in preferred values	0.25
11W – 1R0 to 22K – Available in preferred values	0.29
17W –1R0 to 22K – Available in preferred values	0.37

Potentiometers

Carbon Track, Rotary 0.25 W Log & Lin values. All ¼" Spindle, 20 ml body dia, Shaft 2' long.

4K7 – 2M2 Single Gang Log	.32	10/£3.00
1K – 2M2 Single Gang Lin.	.32	10/£3.00
5K – 2M2 Single Gang DP Switch Log . . .	.75	10/£7.00
5K – 2M2 Double Gang Log & Lin	.86	10/£8.25

FUSES Prices per 10

1¼" Quick Blow 100, 150, 250mA **£1.30** 1, 1 25, 1 5, 2, 2.5, 3, 10, 15A **55p** **1¼" Time Delay**. 100mA **£3.50** 150mA **£2.25**. 250, 300, 500, 600, 750, 850mA **£1.84** 1, 1 25, 1 5, 1 6, 2A **£1.84** 2 5A, 3 15, 3, 5A **£2.82**. **20mm Quick Blow**. 100, 125, 160, 200, 250, 315, 400, 500, 630, 800mA, 1, 1 25, 1 6, 2, 2 5, 3 15, 4, 5, 6 3A **40p**. **20mm Time Delay**. 100, 125, 160, 200mA **£1 80**. 250, 315, 400, 500, 630, 800mA. **£1.00**. 1, 1 25, 1 6, 2, 2 5, 3 15, 4, 5, 6 3A **85p** **1" Mains** 2, 3, 5, 7, 10, 13A **85p**

Manufacturers please note — we can offer very competitive prices for production quantities of 20 mm Q/Blow and T/Delay range — apply for quotation.

4000	24p	4052	60p	4510	55p
4001	24p	4053	60p	4511	55p
4002	25p	4066	45p	4512	55p
4007	25p	4067	2.45p	4513	55p
4011	24p	4068	24p	4514	1.15p
4012	24p	4069	24p	4515	1.15p
4013	56p	4070	25p	4516	55p
4014	60p	4071	24p	4517	2.70p
4015	60p	4072	25p	4518	48p
4016	40p	4073	25p	4520	53p
4017	60p	4075	25p	4521	1.15p
4018	60p	4076	68p	4522	1.25p
4020	85p	4077	25p	4526	60p
4021	58p	4078	25p	4528	68p
4022	96p	4081	25p	4531	1.30p
4023	35p	4082	25p	4532	65p
4024	50p	4085	58p	4536	2.65p
4025	24p	4086	58p	4538	80p
4027	45p	4089	1.25p	4539	90p
4028	45p	4093	37p	4541	90p
4029	75p	4094	95p	4543	1.25p
4030	35p	4095	95p	4549	4.00p
4031	1.30p	4096	99p	4553	2.45p
4033	1.25p	4097	2.65p	4554	1.92p
4034	1.46p	4098	80p	4555	35p
4035	70p	4099	1.05p	4556	55p
4036A	2.75p	4161	96p	4557	2.50p
4038	75p	4162	96p	4558	1.20p
4039A	2.80P	4163	96p	4559	3.25p
4040	60p	4174	96p	4560	1.80p
4042	50p	4175	1.00p	4562	3.50p
4043	42p	4194	99p	4566	1.75p
4044	50p	4501	38p	4569	1.95p
4046	60p	4502	38p	4583	1.05p
4049	38p	4503	40p	4584	55p
4050	36p	4507	48p	4585	70p
4051	70p	4508	1.30p	4724	1.10p

MICRO

2764-250n/s	£5.80
Z80A-CPU	£3.70
Z80A-CTC	£3.30
Z80-ADNA	9.00
Z80-AP10	3.40
Z80-AS10/0	8.75
Z80-AS10/2	8.99

VEROBOARD

	0.1in.Clad.
2½ x 3¾"	85p
2½ x 5"	1.00
3¾ x 3¾"	1.05
3¾ x 5"	1.15
2½ x 17"	3.25
3¾ x 17"	4.10
4¾ x 17¾"	4.95
Pkt.of 100 pins	.50
Spot face cutter	1.48
Pin insert.tool	1.83
Vero Wiring Pen + spool	3.50

VEROBOARD

	0.1in.PLAIN.
3¾ x 5"	.95
3¾ x 17"	2.70
DIP Board	3.85
Vero Strip	1.25
HAND HELP CONTROL BOXES	.75

TERMINAL BLOCKS

2 amp 12 way	.19
5 amp 12 way	.20
15 amp 12 way	46
32 amp 12 way	.92

MIN. "D" CONNECTORS.

		9way	15way	25way	37way
PLUGS	Solder Lug	.52	.65	.88	1.45
	R. Angle	.89	1.34	1.98	3.48
SOCKETS	Solder Lug	.78	.98	1.33	2.48
	R. Angle	1.18	1.78	2.70	4.15
COVERS		.95	.95	.98	1.00

ST CORNWALL COMPONENTS.
EPT. KK6
HIGH STREET,
EM
REWSBURY SY4 5TT. TEL. 0939 32689 TELEX 35565

ORDERING: All components are brand new and to full specification. Please add 50p postage/packing (unless otherwise specified) to all orders and then add 15% VAT to the total. Either send cheque/cash/postal order or send/telephone your Access or Visa number. Official orders from schools, universities, colleges etc most welcome. (Do not forget to send for our 1985 catalogue — only 65p per copy — details at top of advertisement.)

NEW RETAIL 1000 sq ft shop now open Mon-Fri 9.00-5.00. Sat 9-12.00.

BAKERS DOZEN PARCELS

All the parcels listed below are brand new components. Price per parcel is £1.00, but if you order 12 you get one extra free.

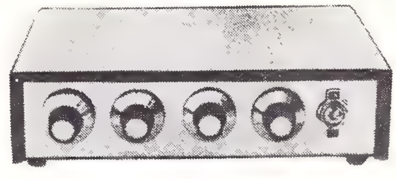
1 5 13 amp ring main junction boxes
2 5 13 amp ring main spur boxes
3 25 13 amp fuses for ring mains
4 5 surface mounting switches suitable insulated for mains voltage
5 3 flush electrical switches intermediate type, will also replace 1 or 2 way switches
6 5 in flex line switches
7 4 in flex line switches with neons
8 2 80 watt brass cased elements
9 2 mains transformers with 6v 1a secondaries
10 2 mains transformers with 12v ½a secondaries
11 1 extension speaker cabinet for 6½" speaker
12 5 octal bases for relays or valves
13 12 glass reed switches
14 4 OCP 70 photo transistors
15 25 assorted germanium transistors OC45 etc
16 4 tape heads, 2 record, 2 erase
17 2 ultra sonic transmitters and 2 ditto receivers
18 2 15000 mfd computer grade electrolics
19 2 light dependent resistors similar ORP12
20 5 diff micro switches
21 2 mains interference suppressors
22 2 25 watt crossover units
23 1 40 watt 3 way crossover unit
24 250 various screws and self tappers
25 1 of each wafer switches — 6p 2 way; 4p 3 way; 2p 6 way; 1p 12 way
26 2 tape deck counters
27 1 6 digit counter 12v
28 1 6 digit counter mains voltage
29 1 BOAC in flight stereo unit (second hand)
30 2 Nicad battery chargers
31 1 key switch with key
32 2 humidity switches
33 2 aerosol cans of ICI Dry Lubricant
34 96 × 1 metre lengths colour-coded connecting wires
35 4 battery operated model motors
36 2 pair spaced 2 gang tuning condensors
37 2 solid diaelectric 2 gang tuning condensors
38 10 compression trimmers
39 Long and Medium wave tuner kit
40 4 × 465 KC IF transformers
41 8 Rocker Switches 10 amp Mains SPST
42 6 Rocker Switches 10 amp Mains SPDT
43 5 Rocker Switches 10 amp SP DT Centre Off
44 4 Rocker Switches 10 amp DPDT
45 1 24 hour time switch mains operated (secondhand)
46 1 6 hour clockwork timeswitch
47 2 lever switches 4 pole changeover up and ditto down
48 2 6v operated reed switch relays
49 10 neon valves — make good night lights
50 2 × 12v DC or 24V AC 4C0 relays
51 1 × 12v 2C 0 very sensitive relay
52 1 × 12v 4C 0 relay
53 2 mains operated relays 3 × 8 amp changeovers (secondhand)
54 10 rows of 32 gold plated IC sockets (total 320 sockets)
55 1 locking mechanism with 2 keys
56 Miniature Uniselector with circuit for electric jigsaw puzzle
57 5 Dolls' House switches
58 2 telephone hand sets incorporating ear piece & mike (s/hand)
59 2 flat solenoids — ideal to make current transformer etc.
60 5 ferrite rods 4" × 5/16" diameter aerials
61 4 ferrite slab aerials with L & M wave coils
62 4 200 earpieces
63 1 Mullard Thyristor trigger module
64 10 assorted knobs ¼ spindles
65 5 different thermostats, mainly bi-metal
66 magnetic brake – stops rotation instantly
67 three levels of low pressure switch
68 heavy duty 4 pole conductor — 24v coil
69 2 25 watt pots 8 ohm
70 2 25 watt pots 1000 ohm
71 4 wire wound pots — 18, 33, 50, 100 ohm
72 6 assorted slider pots including 2 stereo
73 4 3 watt wire wound pots 50 ohm
74 50 ⅓ watt carbon film resistors – good spread, 10 values
75 20 2 watt carbon resistors
76 30 1 watt carbon resistors spread of values
77 1 time reminder adjustable 0-60 mins.
78 5 5 amp stud rectifiers, 400v
79 4 2a bridge rectifiers, 400v
80 2 10a bridge rectifiers, 30v
81 2 30a panel mounting slydlok fuses
82 4 porcelain fuse holders and fuses
83 1 fluorescent choke — your choice — 15, 20, 30, 40 or 65 watt
84 10 1 mains suppressor condensors
85 1 mains shaded pole motor ¾" stack
86 2 5" ali fan blades fit ¼" shaft
87 2 3" plastic fan blades fit ¼" shaft
88 mains motor suitable for above blades
89 1 mains motor with gear box 1 rev per 24 hours
90 1 mains motor with gear box 1 rev per 12 hours
91 2 mains motor with gear box 16 rpm
92 4 fluorescent starters for 4 - 80 watt tubes
93 4 11 pin bases for relays
94 5 B7G valve bases
95 4 skirted B9A valve bases
96 1 fridge stat
97 1 infra red fire element 1000 watts
98 1 motorised stud switch (SH)
99 5 assorted ferrite shapes
100 3 ferrite magnets
101 1 2½ hour delay switch
102 1 9v mains power supply unit
103 1 6v mains power supply unit
104 1 4½v mains power supply unit
105 1 5 pin plug and socket
106 2 12v vibrating reed bleepers
107 5" speakers size radio cabinet with handle
108 5 different multi way push switches
109 10 ¼" spindle type volume controls
110 10 slider type volume controls
111 2 musical boxes (less keys)
112 1 heating pad 200 watts mains
113 1 fm front end with tuning condensor
114 1 1w amplifier Mullard 1172

The AMSTRAD Stereo Tuner

This ready assembled unit is the ideal tuner for a music centre or an amplifier, it can also be quickly made into a personal stereo radio — easy to carry about and which will give you superb reception.

Other uses are as a "get you to sleep radio", you could even take it with you to use in the lounge when the rest of the family want to view programmes in which you are not interested. You can listen to some music instead.

Some of the features are: long wave band 115-270 KHz, medium wave band 525 — 1650 KHz, FM band 87 – 108 MHz, mono, stereo & AFC switchable, fully assembled and fully aligned. Full wiring up data showing you how to connect to amplifier or headphone and details of suitable FM aerial (note ferrite rod aerial is included for medium and long wave bands). All made up on very compact board Offered at a fraction of its cost. **only £6.00**



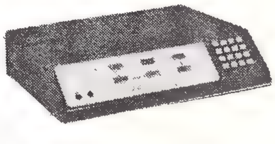
SOUND TO LIGHT UNIT

Complete kit of parts for a three channel sound to light unit controlling over 2000 watt of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special price is **£14,95** in kit form or **£25.00** assembled and tested.

CAR STARTER/CHARGER KIT Flat Battery! Don't worry you will start your car in a few minutes with this unit – 250 watt transformer 20 amp rectifiers, case and all parts with data £16.50 transformer only £12.50.

4/5A BATTERY CHARGER Transformer and rectifier £3.95 & £1 post, 3 kits £12 post paid.

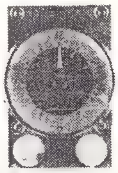
PRESTEL UNITS



These are brand new and we understand tested, came with manufacturer's guarantee now void as the manufacturer no longer trades. These originally sold for over £150. We offer them complete, except for 7 plug in i.c.'s and price is only £14.95 (less than the value of the modem included).

STABILISED POWER SUPPLY (Mains Input)

By LAMDA (USA) — Ideal for computer add-ons, d.c. output Regulated for line volts and load current. Voltage regulation .1% with input variations up to 20% — load regulation 1% from no load to full load – or full load to no load. Complete in heavy duty case — Models available: 5v – 9A **£23**
£13.25. 15v — 1,2A **£13,25.** 24v 2A **£23.**



25A ELECTRICAL PROGRAMMER
Learn in your sleep: Have radio playing and kettle boiling as you wake — switch on lights to ward off intruders — have a warm house to come home to. You can do all these and more. By a famous maker with 25 amp on/off switch. Independent 60 minute memory jogger.
A beautiful unit at **£2.50.**

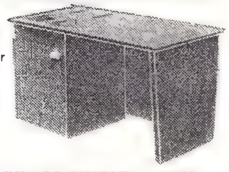
THIS MONTH'S SNIP

TOP OF THE POPS LIGHTING if you use our disco switch

These have 12 × 10 amp changeover switches each rated at 10 amps so a whole street could easily be lit with one. Switches adjustable and could be set to give a running light, random flashes, etc etc. 230 volts main operation. Brand new, made by Honeywell. Offered at approximately one third of cost

ONLY £6.90

COMPUTER DESKS



Again available · Computer desks – size approx 4' x 2' x 2'6" high formica covered, cost over £100 each. Our price only from £9.50 – you must collect – hundreds supplied to schools.

50 THINGS YOU CAN MAKE

Things you can make include Multi range meter, Low ohms tester, A.C. amps meter, Alarm clock, Soldering iron minder, Two way telephone, Memory jogger, Live line tester, Continuity checker, etc. etc., and you will still have hundreds of parts for future projects. Our 10Kg parcel contains not less than 1,000 items - panel meters, timers, thermal trips, relays, switches, motors, drills, taps, and dies, tools, thermostats, coils, condensers, resistors, neons, earphone/microphones, nicad charger, power unit, 90% are unused componants

YOURS FOR ONLY £11.50 plus £3.00 post.

REVERSIBLE MOTOR WITH CONTROL GEAR

Made by the famous Framco Company this is a very robust motor size approximately 7½" long, 3½" dia. 3/8" shaft Tremendously powerful motor, almost impossible to stop. Ideal for operating stage curtains, sliding doors, ventilators etc., even garage doors if adequately counter-balanced. We offer the motor complete with control gear as follows

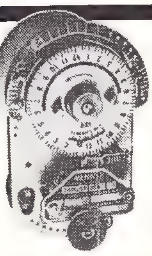
1 Framco motor with gear box
1 manual reversing & on/off switch
1 push to start switch
2 limit stop switches
1 circuit diag. of connections

£19.50 plus postage £2.50

IONISER KIT

Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder — a complete mains operated kit, case included.

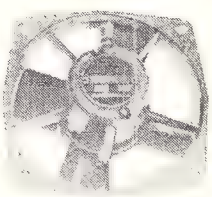
£11.95 plus £2.00 post.



VENNER TIME SWITCH

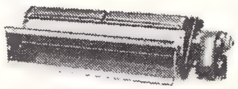
Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only **£2.95.** without case, metal case - **£2.95**, adaptor kit to convert this into a normal 24hr. time switch but with the added advantage of up to 12 on/offs per 24 hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is **£2.30.**
Ex-Electricity Board.
Guaranteed 12 months.

EXTRACTOR FANS – MAINS OPERATED



Woods extractor.
5" – £5.75, Post £1.25
6" – £6.95, Post £1.25.
5" Plannair extractor £6.50. Post £1.25.
4"x 4" Muffin 115v. £4.50. 230v. £5:75. Post 75p.
All the above ex-computer, those below are unused.
4" x 4" £8.50. Post 75p.
9" American made £11.50. post £2.00.
Tangential Blower 10×3 air outlet, dual speed £4.60. Post £1.50.

TANGENTIAL BLOW HEATER



by British Solartron, as used in best blow heaters. 3Kw **£6.95** complete with 'cold' 'half' and 'full' heat switch, safety cut out and connection diagram.

Please add post £1.50 for 1 or 3 for £20 post paid

2.5 Kw KIT Still available: **£4.95 + £1.50 post.**
or have 3 for £16 post paid

ROCKER SWITCHES Standard size fit 11.5 x 28 mm cut out. Single pole on/off – 15p each 1000 for £75. Single pole changeover 20p each — 1000 for £100. Single pole changeover with centre off – 25p each – 1000 for £125. Single pole on/off with neon – 36p – 1000 for £180.

ROCKER SWITCH DP/DT 15 amp 250 volts suitable for motor reversing etc. – 46p – 100 for £34.50, 1000 for £230.

MICRO SWITCHES V3 type all 250 10 amp SpST 20p 1000 – £100 Spdt 30p 1000 – £150, very low tongue Spdt 40p 1000 for £200.

MINI MONO AMP on p.c.b., size 4" × 2" (app.)

Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp Brand new, perfect condition, offered at the very low price of **£1.15 each, or 10 for £10.00.**

WALL MOUNTING ROOM THERMOSTAT

By Danfoss has a really pretty two tone grey case with circular white scale and dial. Setting temperature from 0 – 30 c – 13 amp 250v contacts. Price £4.60. – 10 for £40.

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2 pole, 2 way – 4 pole, 2 way - 3 pole, 3 way - 4 pole, 3 way – 2 pole, 4 way – 3 pole, 4 way – 2 pole, 6 way – 1 pole, 12 way.
All at 25p each or 10 for £2.00

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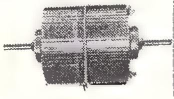

Made for use in cars, etc. these are very powerful and easily reversible. Size 3½" long by 3" dia. They have a good length of ¼" spindle –
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Ditto, but double ended **£4.25.**

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We have very large stocks of motors from 2 watts to ¼ hp. Most at a price well below cost, let us know your requirements.

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elektor switchboard

LMOST COMPLETE set E.T.I., ug. 76 to Feb. 85 (4 missing). £10 o Cancer Research + carriage. hone Lambert, Byfleet 41772.

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ATONG Morse keyboard. Keybo-rd memory plus 4 preset memo-es. Variable speed and weight. acrifice £50. Phone Sapcote 2955.

VANTED: to change software for pectrum. Dragan Karovic, 3200 acak, Dragise Misovica 24, Yu-oslavia.

BC MICRO, DFS, Cumana Disc rive, software, leads and 12 discs. otal cost £693.93, 4 months ago. ell for £450. Phone 0334 88461 St. Andrews).

VANTED: Circuit and data on DU type 3QQDM9 by Chuomusen o. Will pay costs + for info. Ring ed, after 6 p.m., on 0706 874928.

2102 STATIC RAMS — I have 70 of these going for 90p each (normally £2 to £3 each). Tel. 0392 56971.

WANTED: Elektor no. 51/52 and 84. Fair price paid. M. Horton, 38, West Walk, East Barnet, Herts. EN4 8NU.

4 SMOKE DETECTOR modules, uncased but believed to be in working order. £5 each, no data. Paul Leverett, 5 The Close, Hardmead, Newport Pagnell, Bucks. MK16 9LA.

DIGITAL FREQUENCY METER kit for sale, £50. Wish to use test equipment but I am unemployed. Can you help? Call D. Jones, 01 249 4829.

WW SC84 COMPUTER, set of 3 PCBs, FDC, CRT, chips, sockets, all unused. Also two 8" NCR disc drives with PSU. Offers? Mr E Rio-Sixto, 41 College Road, Sandy, Beds. SG19 1RJ. Tel. (0767) 82381.

OSCILLOSCOPE 545, 2 plug ins, 2 probes, Manuals. Needs attention. £60 o.n.o. M.T. French, 66, Louisville Road, London SW17 8RU. Tel. 01 672 9322.

MAPLIN Universal Timer, built and working, needs case and transformer — £35 o.n.o. Tel. Earle, 01 627 3751, 6 p.m. onwards.

SURPLUS to requirements: 2532 £3; 4116 60p; 4864 £3; 6821/6850 150p; 6845/8027 £4; 2114 150p; 6116/2016 £3.50; 2764 £4.50. Phone 0222 797956.

I am going to build the Elektor PIANO from the 1978 September issue. Does anyone out there have the PCB, components/Advice? H.D.C. Stodell, 322 Camrose Avenue, Edgware, Middlesex, Tel. 01 952 0553.

OSCILLOSCOPE — Scopex, 4S6 Single beam 6MHz, good working order, little used, as new, instruction manual — £90. Tel. 01 500 1340.

ELEKTOR BOARDS — fully populated; Floppy £7, 64kDRAM £40, 8kRAM/EPROM £15, Video £40, CPU £45. Cherry ASCII Kbd £10. Phone Chris, (0252) 546739.

FOR SALE: Newnes Radio & TV Servicing 1963/74 — offers accepted. Many other books/magazines — details on request. Mr F.D. Brown, 6 Ryan Close, Ferndown, Wimborne, Dorset BH22 9TP. Tel. Ferndown (0202) 877620.

HEATHKIT RX, any offers/could rebuild? Tel. Bob, Keynsham 67737.

WANTED: Casio MA1 alarm clock, LSI uPD1872GA/S, spares for Sony headphone MDRA30, Spectrum — latest software for swap on tape. Hamid-Reza Tajzadeh, 4th floor, no. 11, street no. , Naarmack, Tehran 16479, Iran.

I want to buy a computer new or used. Seller may contact me with price and computer details. M. Ahmadian, No. 9, Vatan pour Dead End, Hossainy St., Damavand Ave., Tehran 16419, Iran.

SELL OR SWAP Tamron 35-70 Zoom lens, new, also Idiscomp RS232/parallel interface for Spectrum, Vic-20, 64K RAM card, no chips. Mr M. Saunders, 7 Drumcliff Road, Thurnby Lodge, Leicester LE5 2LH.

COMPLETE SET Elektor magazines 1975 to 1983, no. 1 to 104. Inclusive reasonable offers please! Tel. 0438 832634.

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- Elektor cannot accept responsibility for any correspondence or transaction as a sult of a 'switchboard' ad, nor as a result any inaccuracy in the text.
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- We reserve the right to refuse advertisements, without returning them.

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elektor switchboard JUNE 1985

back number service

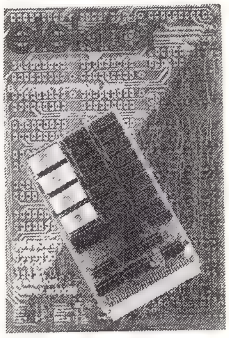
E34, February 1978
Infra-red Light Gate/Throwing Some Light on LEDs/Format — the Elektor Music Synthesiser (c)/Slow on/off/CMOS Function Generator/Zener/Tester/Development timer/Experimenting with the SC/MP (4).

E38, June 1978
¼ GHz Counter/Constant Amplitude Squarewave to Sawtooth Converter / Servo Polarity changer / Monopoly Dice / Mini Counter / Digital clock Using the SC/MP/Programmable Call Generator / TV Sound Modulator/ Automatic Stereo Switch/Trafic Light controller.Easy Music.

E54, October 1979
Touch Tuning/Battery Saver/Impedance Bridge/New Programs for the SC/MP/Digital Rev Counter/Digifarad/Short-interval Light Switch/PCB for Variable Fuzz Box/Gate-dipper/Strain Gauge/I Played TV Games/Programmable Sequencer.

E55, November 1979
Topamps/Flash Sequencer/Electronnics the Easiest Way/Remote control Motor Switch/Home Trainer/fuel Economiser/I Played TV Games (2)/Shortwave converter/Ionosphere/Low Voltage Dimmer/I See your Point/Servo-controlled Motor.

E58, February 1980
Aerial Booster/Fet Opamps in the Formant / TV Interference Suppression / Elektor Vocoder (2)/ Aerial Amplifiers / Digisplay/ Analogue Delay Technology / Extending the ¼ GHz Counter/ Digital Thermometer.

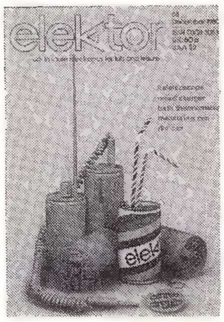


E65, September 1980
8K RAM + 4.8 or 16K EPROM on a Single Card/Precision Power Unit/Electronic Linear Thermometer/The Josephson Computer/VOX Printed Circuit Board/ Ejektor: Measuring Multipath/ High Speed Readout for Elekterminal/Musical Box/Electrolytology/Curve Tracer/Using the Vocoder.

E66, October 1980
Programmable Slide Fader/Touch Doorbell/Switched Capacitors/ More TV Games/The Junior Computer Memory Card/Remote Control Slide Projector/Video Pattern Generator/LCD Tuning Scale/ Dual Slide Faders.

E67, November 1980
An r.p.m. Indicator as an Economy Guide/Draught Detectir/How to Recycle Dry Cell Batteries/ Energy Saving Know-how/Simple fuel Economy Meter/Automatic Pump Control/Long Life Technique in Light Bulbs/Automatic Curtain Control/Fridge Alarm/ Know the ins and outs of your Central Heating system/Energy/ Energy Saving Motor Control/Coffee Machine Switch/Operational Hours Counter.

E68, December 1980
Canned Circuits: 23 of the best entries which include Midnight Raid Detector/A 'Flash in the Can'/ Canometer/Canine Defence.



E70, February 1981
Audio Power Meter/Noise Reduction/Process Timer/High voltage from 723/Juniors Growing Up/ The Voiced/Unvoiced Detector/Emergency Brake for the Power Supply/150 W DC to DC Converter for the Car/Low Noise 2 Metre Pre-Amp/2½ Digit DVM/ Wagnephon.

E72, April 1981
Transistor Match-maker/Universal Power Supply/Intelekt/Humidity Sensor/Logic Analyser II/Crystal-controlled Stroboscope/Junior Cookbook.

E73, May 1981
Camping Clock/Frequency Double/The Fully Fledged Junior Computer/Talk to Computers/ Choke Alarm/Bar Codes/Logic Analyser/Waveform Generator/ Sophisticated software for the Junior Computer/Reading Bar Codes.

E77, September 1981
DFM + DVM/Revolution Counter/Digital Barometer/dB Converter/TV Games Extended/Disco Lights Controller/QUAD ESL 63/ Analogue LED Display/Volt/Ammeter for Power Supplies/Chattering Chips/Transistor Ignition Update/Soldering Aluminium.

E89, September 1982
Gas Detector/Rapid Loading Games/The Elektor Connection/ Inductive Sensor/Darkroom Computer Part 1/Applikator/Home Telephone System/Synthesised Sound Animation/Time Receiver for the Rugby MSF/Three Phase Tester.

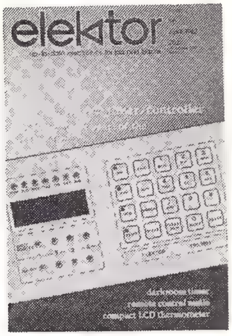
E90, October 1982
DSB Demodulator/L.C.D. Thermometer/Ultra Sonic Distance Measurement/Electrolytics Run Dry/Darkroom Computer Part 2/Short Wave Band Shifting for SSB Receiver/16 Channels with only Five ICs/Pre-amp for the SSB Receiver/Active Aerial/Transistor and IC Data.

E91, November 1982
Drum Interface/Talking Dice/ Model Train Lighting/Guitar Tuner/Cerberus/Floppy Disc Interface for the Junior/Cubular Bell/Mini-Organ Extension/Kitchen Timer.

E93, January 1983
Milliohmmeter/accessories for the Crescendo power amplifier/Darkroom computer tips/Chips for digital audio / 3 A computer supply/Traffic-light control system / Tomorrow's music / Upper and lower case on the Elekterminal.

E94, February 1983
Prelude part 1/VAM — video/ audio modulator/Main beam dimmer/Prelude class A headphone amplifier/Fuse protector/Acoustic telephone modem/Double dice/ Chips for digital audio part 2.

E96, April 1983
Low power digital thermometer/ MC/MM phono preamp/Membrane switches/Interlude/RC equalizer / 7-day timer / controller/Junior program tester/ Prelude (part 3)/Programmable darkroom timer/Talking clock extension.



E97, May 1983
Wattmeter/ASCII keyboard/Prelude p.s./Multitester/Maestro (part 1)/What is power?/Parallel-serial keyboard converter/Morse converter/78L voltage regulators ...and 79L/Morse decoding with the Z80A.

E99/100, July/August 1983
Summer Circuits Double Issue containing over 100 projects.

E101, September 1983
Video Graphics/Autotest/64k on the 16k Dynamic RAM Card/high-speed CMOS/VDU Card/Personal FM/Precision Voltage Divider/ alarm Extension/Junior Synthesizer/Simple MOSFET Test.

E102, October 1983
Basicode-2 / Music Quantisizer/ Solid-state Darkroom Lighting/ High-voltage Regulator / Anemometer / Programmable Power Supply/Basicode-2 Interface for the Junior Computer/Electronic Voltage Regulator / Battery Eliminator/Transistor Selector/FSKleaner/EPROMmer using the Junior Computer.

E103, November 1983
Doorbell — or telephone — operated flashlight/Power Controller for Model Railways/ Decoupling in Digital Circuits/CPU Card/Decimal to Binary Converter/Movement Detector/Electronic two-tone Metronome/ Pseudo Stereo/Universal Terminal/Ultrasonic/Infrared Barrier/Trick battery/Crescendo revisited.

E104, December 1983
64-way 2-dimensional Bus Board/MF/HF USB Marine Receiver/LED Ornaments/Symmetrical Power Supply/Video Amplifier/Locomotive Headlamp Reverser/Frost Warning Device/ Disco Phaser/Banking Program/ NOV-RAM: Data Storage without Batteries/Bus Extension/ + Cumulative index 1983.

105, January 1984
Gyrophone/How accurate is your watch?/Digital Cassette Recorder/Audio Signal Embellisher/ Universal Active Filter/from Thermometer to Thermostat/Audio Sleuth at work/Wind Direction Indicator/Z80 EPROM programmer/ Home-made low-cost Wiring Probe/Address deding.

E106, February 1984
6502 Tracer/Diesel Tachometer/ Programmable Disco Display Lights/Video Combiner/Digitester with a difference/Reversing Buzzer/Memory timing/Mating Logic Families/Capacitance Meter/Basicode 2 for Junior plus VDU Card/Constant Voltage Source/CS Chip Selekt/Video Sync Box.

E107, March 1984
Petrol Saver/Triac Control Board/ UHF Video and Audio Modulator/ GET & GO/Elabyrinth/Varistor Protection Circuits / Real-Time analyser (part 1)/Applicator/Tape Timer.

E108, April 1984
Optical Memories/Controlling the Floppy-disk Drive Motor/Pulse Generator/Using the Pulse Generator/Intelligent EPROM Eraser/ Z80 simulator/Metronome Extension/Real-time analyser, part 2/ Variable A.C. Power supply/Idlist/ Chip Selekt/Tape Contents Detector.

E109, May 1984
Noise Squelch/Short-wave Pocket Radio/Floppy Tester/ Switching Power Supply/Analytical Video Display/Aviary Illumination/How many Watts?/Mini Crescendo/a look at EXOR and EXNOR Gates/EPROM Copier/ Digital Cassette Recorder revisited/Real-time Analyser, part 3/RS423 Interface.

E110, June 1984
Portable Distress Signal/ZX Extensions/Disco Drum/Daisywheel Typewriter Printer Interface/Maximum and Minimum Memory/ Lead-acid Battery Charger/Wireless Microphone/Merging BASIC Programs/Echo Sounder/Versatile Audio Peak Meter.

E111/E112, July/August 1984
Summer Circuits Double Issue containing over 100 projects.

E113, September 1984
Data Communication by Telephone/Active cross-over Filter/ Digital Cassette Recorder with the ZX81/Flash Meter/Digital Tachometer/DIRPUT/SCART Adapter/ Anodizing Aluminium / Lamp Saver/Double-sided Printed Circuit Boards

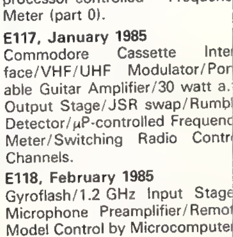
E114, October 1984
The Sinclair QL — first impresions/Basicode-2/Tuning Fork/Balancing Transformers Video colour Inverter/Programming the 6845/ZX81 Cassette Pulse Cleaner/Direct-coupled Modem/ Battery Tester/RS232 centronics Converter/Dynamic Pre-amplifier.

E115, November 1984
The Story of Valves/Autodim/ Mini Printer/Burglar Deterrent/ How to make your own PCBs/ RS232/V24: the Signals/Use you TV Receiver as a Monitor/Tele phase/Valve Amplifier/Electroni Gas Meter.

E116, December 1984
Electronic Candle/The XR2206 i the function Generator/Shorthan BASIC/Function Generator/Tim Switch/Cumulative Index 1984 Musical Greeting Cards/Give you Soldering Tip a longer Life Computer-controlled Slid Fader/Slot-car Controller/Micro processor-controlled Frequenc Meter (part 0).

E117, January 1985
Commodore Cassette Inte face/VHF/UHF Modulator/Por able Guitar Amplifier/30 watt a. Output Stage/JSR swap/Rumb Detector/µP-controlled Frequenc Meter/Switching Radio Contr Channels.

E118, February 1985
Gyroflash/1.2 GHz Input Stage Microphone Preamplifier/Remot Model Control by Microcompute DIY Connector/Programmab Rhythm Box/EPROM Sele tor/Receiver Power from Engi Battery/RLC Meter/Progran mable Keyboard Encoder.



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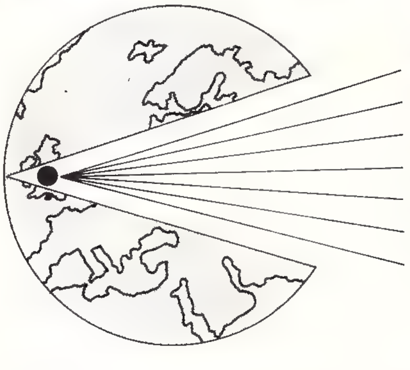

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Buyer c£11k
Berks
Rapidly expanding British company involved within the electronics industry seeks a self motivated specialist to be responsible for the procurement of a wide range of electronic components. Excellent career prospects.

Contact: Stephen Salt, 2 Eton Court, Windsor, Berks. (07535) 54256.

Purchasing Manager c£11k
Surrey
You should be familiar with electronic component purchase and will initially be required to carry out this function. Management expertise whilst not fully utilised at first will be required to enable the formulation of purchasing philosophy within this small rapidly expanding company.

Senior Buyer c£10k
Hants
Responsible for the department during the absence of the Manager and for the procurement of the components for production and development. Familiarity with electronic component purchasing and strict cost/delivery environment is essential.

Materials Manager c£10k
North Surrey
A unique and challenging opportunity to join a rapidly expanding company. You should have a background in the field of petrochemical or gas industries, and a basic qualification in engineering.

Contact: Clive Drury, 2 Tunsgate, Guildford, Surrey. (0483) 65566

Purchasing Manager to £13k
N Home Counties
Our client, a company in the photographic industry, as a result of continued growth wish to recruit a manager to control the key functions of saucing, buying/delivery and to establish effective control systems to monitor achievement.

Senior Buyer to £11k
N Home Counties
Our client, a major manufacturing company seek a senior buyer to join their forward products procurement department. You must have experience of purchasing a wide range of electro mechanical, sheet metal, castings and extrusion components.

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Contact: Nic Watts, 105 St Peter's Street, St Albans, Herts. (0727) 35116
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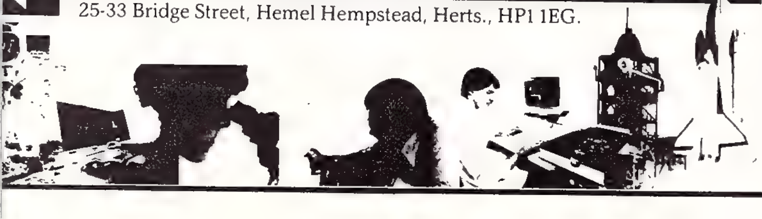

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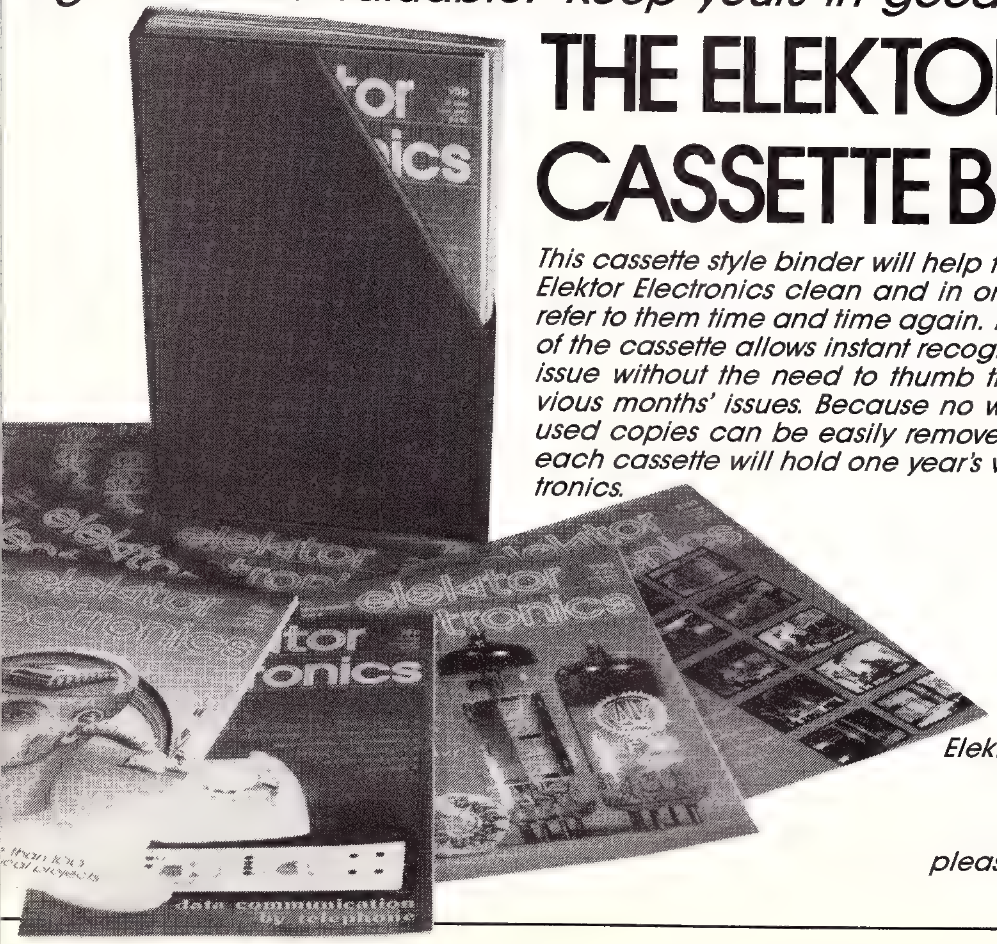

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please use the order card in this issue.

service

Elektor printed-circuit boards, front panels, and software are obtainable from our Canterbury office. Software may also be ordered from Technomatic Limited.

When ordering, please use the order card provided at the end of this issue and state the issue number, or month of publication, of the magazine, the title of the article, and the number of the board, front panel, or software item. Please allow 6/8 weeks for delivery.

Prices in sterling include 15 per cent value added tax, and should be increased by 55p (UK only) or £ 1.10 (other countries, except the USA) for postage and packing.

Prices in dollars are exclusive of any taxes, and include postage & packing for surface mail. If airmail is required, please add $ 1.50.

SUBSCRIPTION SERVICE

January to December incl. (See also Subscription Order Card towards the end of this issue).

United Kingdom		£11.50
USA/Canada	surface mail	$31.00
	airmail	$57.00
Other countries	surface mail	£13.50
	airmail	£27.00

TECHNICAL QUERIES SERVICE

Readers experiencing difficulties in the construction of Elektor projects, published within the last three years, may write for advice to our Canterbury office, enclosing a stamped, self-addressed envelope or, if you live outside the United Kingdom, an International Reply Coupon. Failure to do so may, at best, result in very serious delays in our answer. In any case, please allow on average 8 to 10 weeks for our answer.
If certain components are not immediately available in your area, look carefully through the advertisements in this issue. You'll be surprised how often you can find that elusive part.

BACK NUMBER SERVICE

Only the back numbers listed below are currently available.
Price are as follows:

any one issue (except July/August)	£ 1.50
additional issues, each	£ 1.30
July/August (Summer Circuits)	£ 3.00

Prices include postage and packing. For overseas orders requiring airmail postage add £ 1.50 per issue (£ 2.00 for July/August).

1978: E34, February; E38, June.
1979: E54, October; E55, November.
1980: E58, February; E65, September; E66, October; E67, November; E68, December.
1981: E70, February; E72, April; E73, May; E77, September.
1982: E89, September; E90, October; E91, November.
1983: E93, January; E94, February; E96, April; E97, May; E99/100, July/August; E101, September; E102, October; E103, November; E104, December.
1984: E105, January; E106, February; E107, March; E108, April; E109, May; E110, June; E111/112 July/August; E113, September; E114, October; E115, November; E116, December.
1985: E117, January; E118, February; E119, March; E120, April; E121, May

COPY SERVICE

Photocopies of articles can only be supplied from out-of-print back issues of Elektor. State details of the article required, and the number, or month of publication, of the back issue containing the article together with your name and address on the relevant order card at the back of this issue. Cost of any one article is £ 1.50 (incl. p&p). Cost of additional articles (ordered at the same time) is £ 1.30 (incl. p&p).

BOOK SERVICE

A number of Elektor books is currently available which may be ordered from certain electronics retailers or bookshops or directly from our Canterbury office.

Book 75	£5.30
Digibook (with PCB)	£6.30
300 Circuits	£5.80
Formant (1) (incl. cassette)	£6.30
SC/MPuter (1)	£5.80
SC/MPuter (2)	£5.80
Junior Computer (1)	£6.90
Junior Computer (2)	£6.90
Junior Computer (3)	£6.90
Junior Computer (4)	£6.90
TV Games Computer	£7.10
Resi & Transi (1)	£6.10
Resi & Transi (2)	£4.80
33 Electronic Games	£4.80
301 Circuits	£5.80
Data Sheet Book	£8.40
Paperware 1	£2.10
Paperware 2	£2.10
Paperware 3	£2.70
Paperware 4	£2.80
Microprocessor Hardware	£7.90
VIA 6522	£3.50
Extended Preset Unit for the Polyphonic Synthesizer (photo copy)	£1.60
Automate your model railway	£6.25
Starting electronics Vol. 1	£4.70
Projects for your home workshop	£4.95
Projects for cars and bicycles	£4.95
Projects for amateur photographers	£4.95
Projects for home and garden	£4.95
Infocards (in cassette)	£3.50
Elektor binder	£3.10

FRONT PANEL SERVICE

	No.	£	$
Elektor Artist (E85)	82014-F*	2.80	5.70
precision power supply (E92)	82178-F	2.50	5.00
Prelude (E94...E96)	83022-F*	4.40	8.75
7-day timer/controller front panel including membrane switches	83041-F*	13.10	26.25
Maestro	83051-F	4.90	9.75
capacitance meter	84012-F	5.20	10.50
real-time analyser	84024-F	7.80	15.50
direct-coupled modem	84031-F	4.50	9.00
pulse generator	84037-F*	4.60	9.25
μP-controlled frequency meter	84097-F	10.50	21.00
function generator	84111-F	5.00	10.00
programmable timer	85047-F	14.90	22.25

SOFTWARE SERVICE

μP TV games on cassette	No.	£	$
15 programs: jackpot, reversie, amazone, code breaker, etc.	007*	5.50	11.00
15 programs: invaders, fishing, maze adventure, memory, pontoon, nim, etc.	009	6.90	13.75
15 programs: aliens, flipper, helicopter, pilot, basketball, hangman etc.	010*	6.90	13.75
15 programs: snakes & ladders, snap, mazes, break-out, horse races, cosmic adventure, Omega landing etc.	011	6.90	13.75
Software on EPROMS			
Elbug (original) 1 × 2716	500	8.40	16.75
Elbug II (SC/MP Book) 1 × 2716	501	8.40	16.75
Cassette routine for NIBL computer 1 × 2716	502	8.40	16.75
Junior computer 1 × 2708	503	5.30	10.50
illuminated disco floor 1 × 2708	504	5.30	10.50
Chess program for Intelekt 2 × 2716	505	16.80	33.50
Junior tape monitor (TM) 1 × 2716	506	8.40	16.75
Junior printer monitor & PME 1 × 2716	507-N	8.40	16.75
Reprogrammins 507 to 507-N			
Junior data bus control 1 × 82S23	508	5.30	10.50
Time signal processor 1 × 2716	509	8.40	16.75
150 MHz frequency meter 2 × 82S23	510	10.50	21.00
Junior disassembler, programmable software, system vectors and hexdump 1 × 2716 EPROM	511	8.40	16.75
autonomous switch-clock 1 × 2716 EPROM	512	8.40	16.75
keysoft polyphone keyboard 1 × 2716 EPROM	513	8.40	16.75
dark room computer 1 × 2716 EPROM	514	8.40	16.75
dark room computer ext. 1 x 2716 EPROM	514-N	8.40	16.75
DOS software 1 x 2708 EPROM	515	5.30	10.50
talking dice 1 x 2716 EPROM	516	8.40	16.75
ELEKTERMINAL + elekterminal 1 x 2716 EPROM	517	8.40	16.75
morse program for the Junior Computer 1 x 2716 EPROM	518	8.40	16.75
telex program for the Junior Computer 1 x 2716 EPROM	519	8.40	16.75
ASCII keysoft 1 x 2716 EPROM	520	8.40	16.75
character generator and video routines for DOS Junior 1 x 2732 + 1 x 2716 EPROMS	521	18.90	37.75
character generator and video routines for extended Junior 1 x 2732 + 2 x 2716 EPROMS	522	27.30	54.50
character generator 1 x 2732 EPROM	523	10.50	21.00
quantisizer 1 x 2716 EPROM	524	8.40	16.75
universal terminal 1 x 2732 EPROM	525	10.50	21.00
wind direction indicator 1 x 2716 EPROM	526	8.40	16.75
elabyrinth 1 x 2716 EPROM	527	8.40	16.75
EPROM copier 1 x 2716 EPROM	528	8.40	16.75
analytical video display 1 x 82S23 EPROM	529	10.50	21.00
typewriter interface 2 × 2716 EPROM	530	16.80	33.50
μP-controlled frequency meter 1 × 2732 EPROM	531	10.50	21.00
X-Y plotter 1 × 2732 EPROM	532	10.50	21.00

PRINTED CIRCUIT SERVICE

The following list shows the printed circuits pertaining to projects published within the last six months and which are currently available.

	No.	£	$
E117: JANUARY 1985			
rumble detector	84109	3.15	6.25
portable guitar amplifier	84128	5.60	11.25
30 watt output stage	85001	3.50	7.00
VHF/UHF modulator	85002	2.50	5.00
Commodore cassette interface	85010	2.90	5.75
μP-controlled frequency meter			
main board	85013	11.55	23.00
display board	85014	4.70	9.50
crystal oscillator	85015	2.40	4.75
E118: FEBRUARY 1985			
RLC meter	84102	7.15	14.25
input stage for the frequency counter	85006	4.65	9.25
EPROM switchboard	85007	3.45	7.00
symmetrical microphone amplifier	85009	2.85	5.75
E119: MARCH 1985			
versatile up/down counter	85019	3.15	6.25
darkness-sensitive light switch	85021	2.80	5.25
pH meter	85024	4.85	9.75
KITT scanner	85025	3.95	8.00
AXL amplifier	85027	7.10	14.25
E120: APRIL 1985			
real-time clock	84094	6,70	13.50
first cuckoo in spring	85016	4.70	9.50
X-Y plotter	85020	12.50	25.00
light-powered radio	85042	3.00	6.00
revolution counter	85043	6.10	12.25
10 A power supply	85044	6.75	13.50
E121: MAY 1985			
programmable timer	85047-1	7.10	14.25
	85047-2	7.10	14.25
glow plug modulator	85053	3.40	6.75
automonitor	85054	4.40	8.75
universal I/O bus	85058	10.10	20.25
digitizer	85063	4.10	8.25
E122: JUNE 1985			
tone burst generator	85057	2.90	5.75
infra-red movement detector	85064	7.35	11.00
RAM used as EPROM	85065	2.80	4.25
autoservice timer	85072	8.90	13.25

* In limited supply only; their availability at the time your order is received cannot be guaranteed.

service

PRINTED CIRCUIT SERVICE

The following list is complementary to the one on the opposite page and shows the printed circuits relating to projects which were published more than six months ago. Those marked with an asterisk are in limited supply only and their availability at the time your order is received cannot be guaranteed.

	No.	£	$
E42: OCTOBER 1978			
VHF/UHF modulator	9967*	2.10	4.25
E44: DECEMBER 1978			
elekterminal	9966*	9.90	19.75
E53: SEPTEMBER 1979			
parametric equalizer tone control section	9897-2*	2.20	4.50
E55: NOVEMBER 1979			
busboard	80024	7.70	15.50
E61: MAY 1980			
Junior computer			
main board	80089-1*	16.60	33.25
display board	80089-2*	1.80	3.50
supply board	80089-3*	4.00	8.00
E70: FEBRUARY 1981			
voiced/unvoiced detector			
detector board	81027-1*	3.60	7.25
switch board	81027-2*	4.30	8.50
E74: JUNE 1981			
Junior Computer			
−12 V supply	81033-2*	1.90	3.75
adaptor board	81033-3*	1.70	3.50
E77: SEPTEMBER 1981			
disco light controller	81155*	4.20	8.50
DFM + DVM	81156*	5.60	11.25
revolution counter	81171*	6.40	12.50
E79: NOVEMBER 1981			
teletext			
decoder board	82001-2	7.10	14.25
power supply	9968-5A	1.90	3.75
high boost	82029*	2.50	5.00
E80: DECEMBER 1981			
70 cm transverter (Oct.)	80133	16.50	33.00
VHF/UHF converter board	9864	2.30	4.50
flashing light	82038*	2.10	4.25
E81: JANUARY 1982			
electronic chimes	82046*	2.10	4.25
E82: FEBRUARY 1982			
universal NiCad charger	82070	2.80	5.50
E84: APRIL 1982			
dynamic RAM card	82017	10.00	20.00
100 W amplifier	82089-1*	3.40	6.75
mini EPROM card	82093*	2.20	4.50
E85: MAY 1982			
6502 housekeeper			
main board	81170-1*	5.40	10.75
display board	81170-2*	4.00	8.00
Z80-A CPU card	82105	9.30	18.50
E86: JUNE 1982			
car alarm	82091*	3.00	6.00
electronic fluorescent light starter	82138*	1.80	3.50
E87/88: SUMMER CIRCUITS 1982			
light-sensitive switch	82528*	2.10	4.25
5 V power supply	82570	2.90	5.75
E89: SEPTEMBER 1982			
darkroom computer part I			
keyboard	82141-1	4.90	9.75
keyboard interface	82141-2*	2.70	5.50
display	82141-3	3.00	6.00
three phase tester	82577	3.50	7.00
E90: OCTOBER 1982			
darkroom computer part II			
light meter	82142-1	2.30	4.50
temperature meter	82142-2	2.10	4.25
process timer	82142-3	2.70	5.50
wave shifter for SSB:			
low frequency converter	82161-1	2.70	5.50
high frequency converter	82161-2	3.00	6.00

	No.	£	$
E91: NOVEMBER 1982			
model train lighting	82157	5.40	10.75
E92: DECEMBER 1982			
precision power supply	82178	5.30	10.50
triopodus electrus diclopus	82179	3.90	7.75
crescendo	82180	6.10	12.25
E93: JANUARY 1983			
3 A computer power supply	83002	2.40	4.75
milli-ohmmeter	83006	2.50	5.00
crescendo d.c. protection and countdown	83008	4.00	8.00
E94: FEBRUARY 1983			
Prelude			
headphone amplifier	83022-7*	5.40	10.75
power supply	83022-8*	4.90	9.75
connection board	83022-9*	7.80	15.50
main beam dimmer	83028	2.00	4.00
E95: MARCH 1983			
64 k memory card	83014	7.80	15.50
Prelude			
bus board	83022-1*	15.20	30.50
line amplifier	83022-6*	6.30	12.50
audio trafic lights	83022-10*	2.80	5.50
digital luxmeter	83037	2.70	5.50
E96: APRIL 1983			
programmable darkroom timer	82048	5.50	11.00
Prelude			
MC prepreamplifier	83022-2*	5.30	10.50
MM preamplifier	83022-3*	6.50	13.00
Interlude remote control preamp	83022-4*	4.90	9.75
tone control	83022-5*	5.10	10.25
7-day timer/controller	83041	5.70	11.50
E97: MAY 1983			
Maestro	83051-1	2.70	5.50
Watt meter	83052*	3.80	7.50
morse converter	83054	3.30	6.50
ASCII keyboard	83058	21.60	43.25
E98: JUNE 1983			
RTTY decoder	83044*	3.50	7.00
Maestro (part 2)	83051-2	16.60	33.25
energy meter	83067	3.60	7.25
spectrum display			
filter board	83071-1	4.20	8.25
control board	83071-2	4.10	8.25
display board	83071-3	4.00	8.00
E99/100: JULY/AUGUST 1983			
Cresthermometer	83410	3.60	7.25
flashing running light	83503	2.40	4.75
μProcessor aid	83515	2.90	5.75
microphone amplifier	83552*	2.70	5.50
simple D/A converter	83558	2.50	5.00
Prelude buffer	83562*	2.30	4.50
heat sink temperature indicator	83563	2.10	4.25
E101: SEPTEMBER 1983			
alarm extension			
transmitter board	83069-1	3.50	7.00
receiver board	83069-2	3.40	6.75
VDU card	83082	13.40	26.75
personal FM	83087	3.00	6.00
E102: OCTOBER 1983			
basicode interface for the Junior Computer	83101-2	2.00	4.00
cosmetics for FSK signals	83106	3.60	7.25
simple anemometer			
memory board	83103-1*	4.80	9.50
measuring board	83103-2*	2.00	4.00
E103: NOVEMBER 1983			
bus board	80024	7.70	15.50
electronic metronome	83107-1*	3.60	7.25
	83107-2*	2.10	4.25
CPU card	83108-1	9.20	18.50
	83108-2	5.70	11.50
speed controller for model railway	83110	4.30	8.50
pseudo stereo	83114*	2.20	4.50
E104: DECEMBER 1983			
64-way bus extender board	83102	10.60	21.25
video distribution amplifier	83113	2.40	4.75
disco phaser	83120-1*	5.60	11.25
	83120-2*	3.50	7.00
symmetrical power supply	83121	4.80	9.50
frost warner	83123	2.50	5.00

	No.	£	$
E105: JANUARY 1984			
audio embellisher	83133-1	3.10	6.25
	83133-2*	4.40	8.75
	83133-3	3.70	7.50
digital cassette recorder	83134	5.50	11.00
wind direction indicator	84001	6.70	13.50
how accurate is your watch	84005-1	4.60	9.25
	84005-2	4.40	8.75
E106: FEBRUARY 1984			
video sync box	83124	2.80	5.50
programmable disco light display	84007-1	10.30	20.50
	84007-2	3.90	7.75
rev counter for diesels	84009	2.00	4.00
capacitance meter	84012-1	5.30	10.50
	84012-2	3.10	6.25
video combiner	84018	2.70	5.50
E107: MARCH 1984			
triac control board	84019	6.10	12.25
Elabyrinth	84023-1	5.00	10.00
	84023-2	4.40	8.75
real-time analyser	84024-1	5.05	10.00
	84024-2	4.30	8.50
UHF video modulator	84029	3.40	6.75
E108: APRIL 1984			
intelligent EPROM eraser	84017	5.30	10.50
real-time analyser	84024-3	15.50	31.00
	84024-4	21.60	43.25
variable a.c. power supply	84035	2.90	5.75
pulse generator	84037-1*	6.40	12.75
	84037-2*	7.70	15.50
E109: MAY 1984			
real-time analyser	84024-5	4.80	9.50
video display	84024-6	8.00	16.00
short wave pocket radio	84040*	6.30	12.50
mini crescendo	84041	6.50	13.00
switching power supply	84049	4.00	8.00
E110: JUNE 1984			
portable distress signal	84048	3.30	6.50
ZX extensions	84054	3.85	8.00
daisywheel typewriter printer interface	84055	5.15	10.50
echo sounder	81105-1*	5.00	10.00
	84062*	5.95	12.00
FM wireless microphone			
transmitter	84063	3.85	7.75
receiver	83087	3.00	6.00
E111/112: JULY/AUGUST 1984			
microcomputer power supply protection	84408	2.45	5.00
economical motor drive	84427	2.55	5.00
fridge alarm	84437	2.55	5.00
VHF/AM air-band converter	84438	3.75	7.50
RS 232 analyser	84452	3.45	7.00
musical doorbell	84457	3.05	6.00
frequency meter	84462	5.50	11.00
μP power supply	84477	5.95	12.00
E113: SEPTEMBER 1984			
electronic cross-over filter	84071	5.95	12.00
SCART adapter	84072	3.55	7.00
lamp saver	84073	2.55	5.00
	84083	2.40	4.75
digital tachometer	84079-1	3.40	7.00
	84079-2	4.60	9.25
flash counter	84081	4.35	8.75
direct-coupled modem design	84031	17.85	35.75
ZX81 pulse cleaner	84075	4.50	9.00
RS232 centronix adapter	84078	6.60	12.25
video inverter	84084	4.05	8.00
E114: OCTOBER 1984			
direct-coupled modem design	84031	17.85	35.75
ZX81 pulse cleaner	84075	4.50	9.00
RS232 centronix adapter	84078	6.60	12.25
video inverter	84084	4.05	8.0
dynamic pre-amplifier	84089	2.85	5.75
E115: NOVEMBER 1984			
burglar alarm	84088	2.70	5.50
valve amplifier	84095	6.30	12.50
autodim	84096	2.65	5.25
telephase	84100	2.50	5.00
TV as monitor	84101	2.70	5.50
mini printer	84106	7.45	15.00
E116: DECEMBER 1984			
time switch	84107	2.75	5.50
function generator	84111	8.15	16.25
give your soldering tip a longer life	84112	2.60	5.25
computer-controlled slide fader	84115-1	11.30	22.50
	84115-2	6.95	14.00
slot-car controller	84130	3.90	7.75

classified ads

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6809
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HARDWARE: (ELEKTORBUS COMPATIBLE)
(PCB's: **£29.95** +VAT — Also Available Built and Tested)
6809 CPU CARD: Full RS232 Serial Interface (6551 ACIA) (with TTL to drive Cassette Interface)
Two Port Parallel Interface (6821 PIA)
Up to 16K EPROM/RAM on board
1MHz or 2MHz operation
64K Static RAM Card: Up to eight 2K/8K devices (with battery backup)
Floppy Disk Interface Card

SOFTWARE: System Monitor (2K) : **£9.95** +VAT
Disassembler (2K) : **£9.95** +VAT
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Fig FORTH Language (8K) : **£34.95** +VAT

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RESi & TRANSi nr. 2

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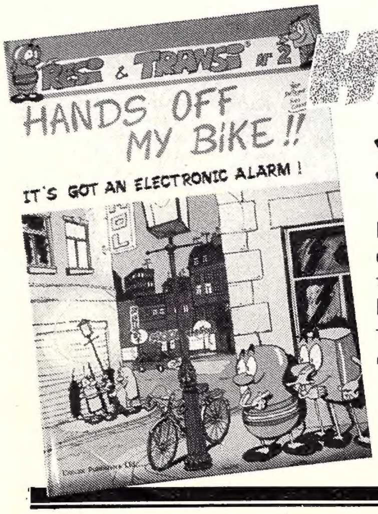

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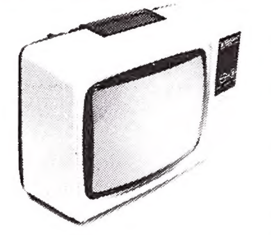

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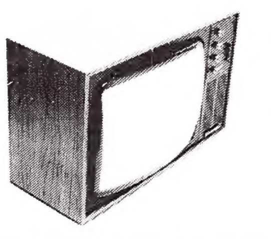

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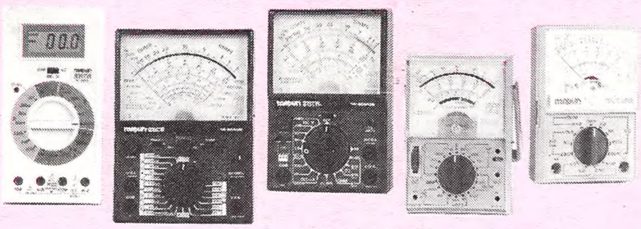

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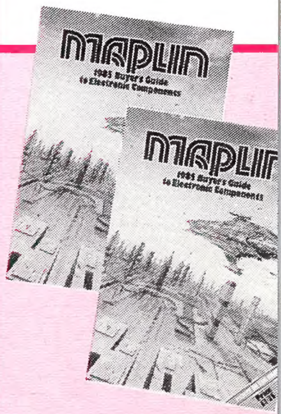
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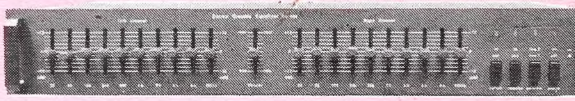

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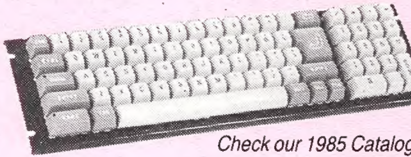

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